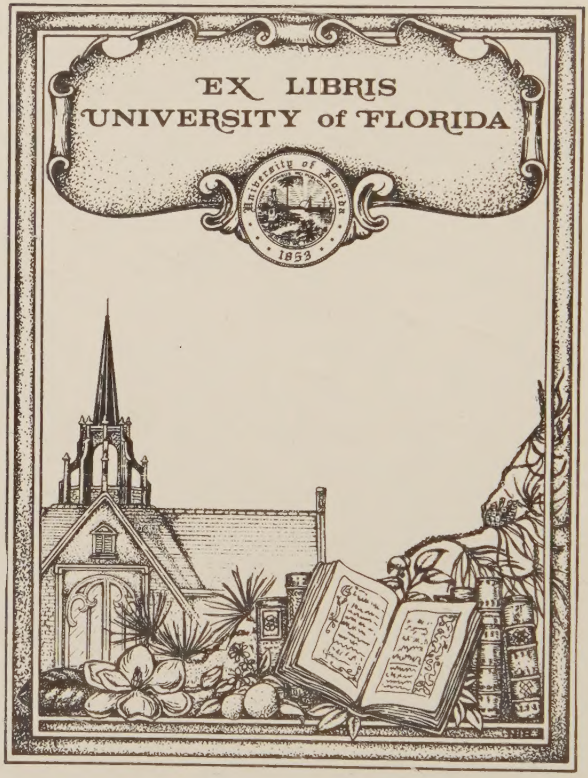
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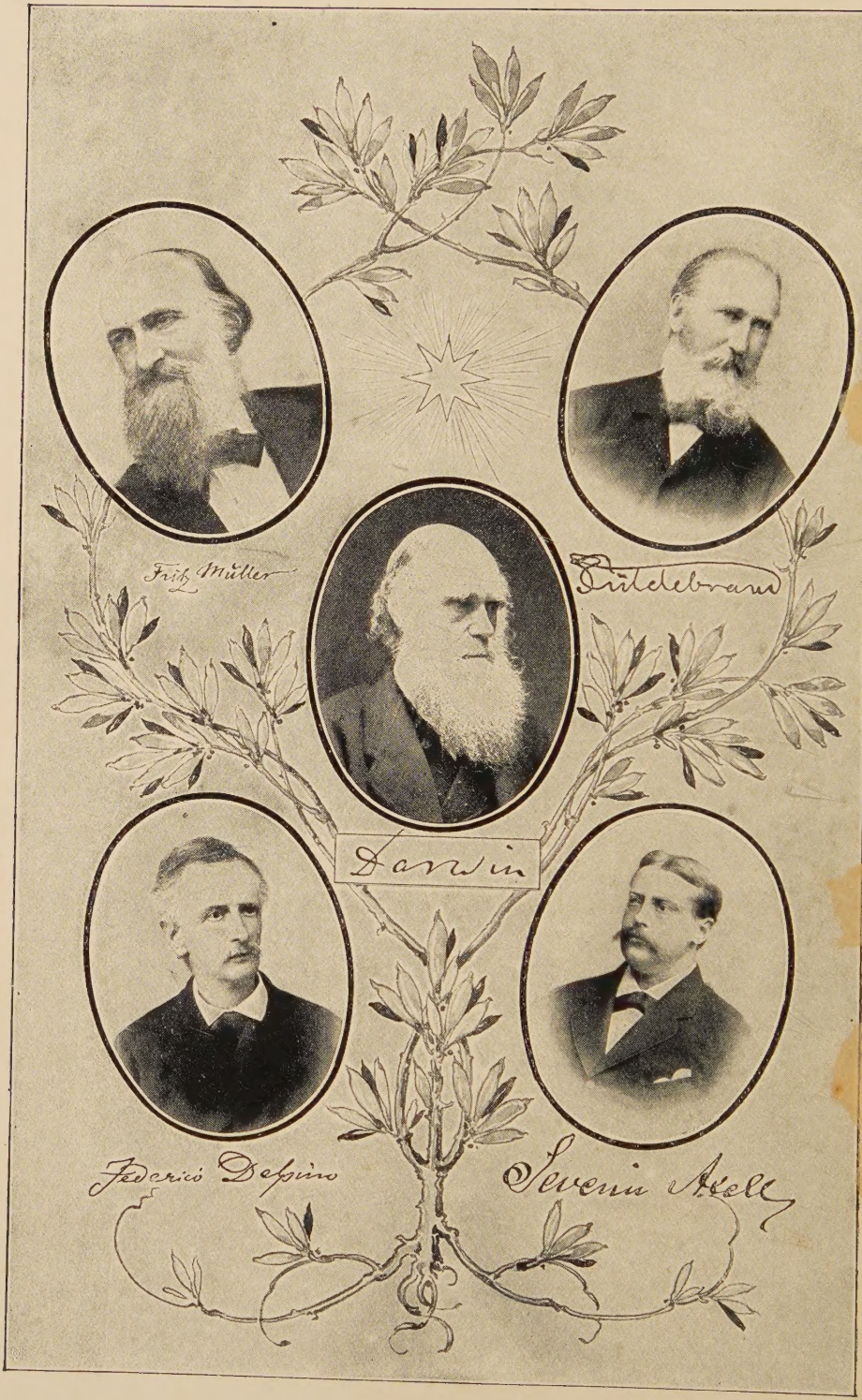
Fritz Müller
Quatrefages
Darwin
Federico Delpino
Severin Axell

HANDBOOK OF FLOWER POLLINATION

BASED UPON

HERMANN MÜLLER'S WORK 'THE FERTILISATION OF FLOWERS BY INSECTS'

BY

DR. PAUL KNUTH

FORMERLY PROFESSOR IN THE OBER-REALSCHULE IN KIEL, AND CORRESPONDING MEMBER OF THE BOTANICAL SOCIETY DODONAEA IN GHENT

TRANSLATED BY

J. R. AINSWORTH DAVIS, M.A.

TRINITY COLLEGE, CAMBRIDGE

VOLUME III

(II. BAND, II. TEIL OF THE GERMAN EDITION)

OBSERVATIONS ON FLOWER POLLINATION MADE IN EUROPE AND THE ARCTIC REGIONS ON SPECIES BELONGING TO THE NATURAL ORDERS

GOODENOVIEAE TO CYCADEAE

WITH 208 FIGURES IN THE TEXT, AND A SYSTEMATIC LIST OF INSECT VISITORS WITH THE NAMES OF THE PLANTS VISITED

DEPARTMENT OF BOTANY AND HORTICULTURE UNIVERSITY OF FLORIDA.

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OBSERVATIONS ON FLOWER POLLINATION

IN

EUROPE AND THE ARCTIC REGIONS

ANGIOSPERMAE

CLASS I. DICOTYLEDONES

LVII. ORDER *GOODENOVIEAE* R. Br.

Literature.—Fritz Müller, Bot. Ztg., Leipzig, xxvi, 1868, p. 115; Delpino, 'Ult. Oss.,' pp. 91–8; Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870, pp. 634–6; Bentham, J. Linn. Soc., Bot., x, 1869, pp. 203–6.

The style terminates in a collecting-cup which takes up the pollen as it passes through the anther-cylinder. It is closed, except for a small opening usually covered by hairs, and therefore able to curve down in the entrance of the generally horizontal flower. Insect visitors strike against the hairs of the collecting-cup, thus causing some pollen to fall upon them. Later on the stigma grows out of the cup and takes up the position previously occupied by the pollen.

505. **Leschenaultia** R. Br.

1687. **L. tubiflora** R. Br.—Darwin states that this species is self-sterile.

LVIII. ORDER *CAMPANULACEAE* JUSS.

1. Tribe Lobelieae.

506. **Lobelia** Plum.

Literature.—Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.,' pp. 64–5. Flowers actinomorphous, and twisted round so as to bring the bifid lip to the upper and the trifid lip to the lower side: corolla-tube split longitudinally. Markedly protandrous. The pollen is dehisced into the anther-cylinder before the flower opens, and lies close to the capitate stigma, which pushes it out as the style elongates. It is either removed by insects or falls away. The few grains which adhere to the stigma are unable to effect automatic self-pollination, as during further development the edge of the stigma rolls back so as to keep them completely away from the receptive surface. Fertilization cannot therefore take place except by transfer of pollen from a younger flower to the stigma of an older one. (The above description is given by Hildebrand for

Siphocampylus, but Farrer says that Lobelia agrees with this in all essential respects.) (*Cf.* Fig. 211.) Some of the species are described as self-sterile, e. g. L. fulgens (Gaertner), L. ramosa (Darwin), and L. cardinalis (Forke).

1688. L. Erinus L. (Delpino, 'Ult. oss.,' pp. 102–11; Hildebrand, op. cit.; T. H. Farrer, Ann. Mag. Nat. Hist., London, Ser. 4, ii, 1868, pp. 255–63; Knuth, 'Bloemenbiol. Bijdragen.')—Hildebrand says that in this species the end of the style is often unable to break through the firmly closed anther-cylinder, inside which the stigmatic lobes then expand, and are self-pollinated. Normally, however, the pollen is swept out of the anther-cylinder during the first stage of anthesis by means of a stylar brush. During the second stage the end of the style emerges from the anther-cylinder and unfolds its two tolerably large stigmatic lobes, which are beset with papillae (*cf.* Fig. 211).

FIG. 211. *Lobelia Erinus*, *L.* (from nature). (1) Flower in the first (male) stage, seen from the front: *a*, the pollen-covered anthers in the entrance of the flower. (2) Ditto, in the second (female) stage, after removal of the corolla: *a*, anther-cylinder, from which the receptive stigma (*s*) protrudes; *n*, nectary. (3) Ditto, in the first stage, after removal of the corolla: *n*, nectary; *s*, the still immature stigma, covered with sweeping-hairs.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Knuth (in his garden at Kiel).—**A. Diptera.** *Syrphidae*: 1. Syrphus corollae *F.* ♀; 2. S. sp.; 3. Syritta pipiens *L.* **B. Hymenoptera.** *Apidae*: 4. Andrena sp.; 5. Apis mellifica *L.* ☿; 6. Bombus terrester *L.* ♀; 7. Halictus minutus *Schr.* ♀. **C. Lepidoptera.** *Rhopalocera*: 8. Vanessa urticae *L.*; 9. Pieris sp. All skg. Delpino, small bees (sp. of Halictus). Ducke (Austrian Silesia), the beautiful parasitic bee Crocisa scutellaris *F.* ♀.

1689. L. syphilitica L. (Urban, Jahrb. bot. Gart., Berlin, i. 1881, pp. 260–77; Delpino, 'Altri appar. dicog. recent. oss.,' p. 16.)—Urban says that the flower mechanism of this species agrees essentially with that of L. Erinus.

VISITORS.—Delpino says that humble-bees are the most frequent (Bombus italicus *L.*—and B. terrester *L.*).

1690. L. Dortmanna L. (MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 442.)—This species bears few-flowered racemes. The corolla is whitish, and its

tube is 7–8 mm. long and $1\frac{1}{2}$–2 mm. broad. MacLeod states that the flower mechanism agrees essentially with that of L. Erinus.

Visitors.—In spite of repeated watching by the Einfelder See (at Neumünster) I failed to observe any.

1691. L. fulgens Willd.—

Visitors.—Delpino (loc. cit.) believes that pollination is effected by humming-birds.

1692. L. laxiflora H. B. et K. (=Siphocampylus bicolor *G. Don*). (Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.,' p. 64.)—The flower mechanism of this species is as described under Lobelia.

Visitors.—Delpino believes that pollination is effected by humming-birds.

507. Isotoma Lindl.

Some of the species have been described as self-sterile.

1693. I. axillaris Lindl. (Hildebrand, Bot. Ztg., Leipzig, xxvii, 1869, p. 476.)—Hildebrand states that the flower mechanism resembles that of Lobelia, but the two lower anthers possess appendages against which visitors strike, causing the pollen to be scattered.

508. Heterotoma Zucc.

The flower mechanism resembles that of Lobelia (Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870, p. 639), but the lobes of the corolla are bent down and produced into a spur, and the filaments are only united together just below the anthers.

509. Monopsis Salisb.

The species of this African genus are homogamous. Urban says that the flowers possess a saucer-shaped stylar brush, by which the pollen is swept out of the anther-cylinder (Jahrb. bot. Gart., Berlin, i, 1881).

2. Tribe Cyphieae.

In this tribe there is a brush on the dilated stigma, which extends to the anthers. These lie close together and shed their pollen to make up a large mass. Insect visitors force the anthers apart, and thus bring their ventral surface into contact with the stigma and the pollen (Delpino, 'Ult. oss,' pp. 100–2; Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870).

3. Tribe Campanulae.

Literature.—Knuth, 'Grundriss d. Blütenbiol.,' p. 68; S. Schönland, 'Campanulaceae' in Engler and Prantl, 'D. nat. Pflanzenfam.,' IV, 5, p. 44.

The species so far examined are markedly protandrous. Those of the genus Campanula bear bee flowers (**Hb**), while the flowers of species belonging to the genera Phyteuma and Jasione are aggregated into capitulate inflorescences, and therefore belong to class **S.**

The flower mechanism has been very thoroughly described by O. Kirchner, who ends his account with the following general considerations (Jahreshefte Ver. Natk., Stuttgart, liii, 1897, pp. 193–228).—

'It is very interesting to observe how the various kinds of adaptation which are associated in the largest order of flowering plants, the Compositae, making their blossoms "the most successful of all flowers," are individually illustrated in the various genera of Campanulaceae. Like all of the latter the Compositae are markedly protandrous, and the two orders agree in the way in which the pollen is deposited on the outside of the style to be carried away by insects, as also in the bending back of the stigmatic branches to the pollen-bearing region of the style so as to make automatic self-pollination possible. The aggregation of numerous small flowers into a head surrounded by an involucre is exemplified by Phyteuma and Jasione, which also agree with the Cympositae in the general accessibility of their nectar, and the free projection of the reproductive organs from the flowers. The union of anthers into a tube surrounding the style is indicated in Jasione, and completely effected in Symphandra. The tubular character of the lower part of the corolla, which in so many Compositae facilitates the ascent of nectar is exemplified by Trachelium, and the annular nectary surrounding the base of the style is found in Adenophora.'

510. Campanula L.

As Sprengel emphasized long since ('Entd. Geh.,' pp. 109–12), species with flowers of the most various size agree in exhibiting marked protandry, and Hermann Müller adds that bees are particularly common visitors ('Fertilisation,' pp. 366–7).

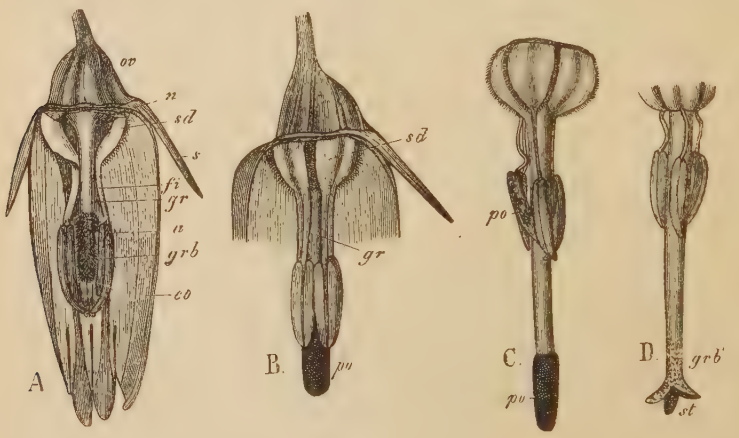


FIG. 212. *Campanula pusilla*, *Haenke* (after Herm. Müller). *A*. Longitudinal section of a young bud. *B*. Reproductive organs of a bud ready to open. *C*. Ditto, of a flower in the first (male) stage. *D*. Ditto, of one in the second (female) stage. *a*, anthers; *co*, corolla; *fi*, filaments; *gr*, style; *grb*, stylar brush; *grb'*, ditto, after the hairs have shrivelled; *n*, nectary; *ov*, ovary; *po*, pollen; *s*, sepals; *sd*, expanded bases of filaments, fringed with hairs and serving as nectar-covers; *st*, stigmas.

The flowers are mostly blue in colour, and Herman Müller states that the nectar is secreted by a yellow fleshy disk situated on the ovary and surrounding the style. It is covered by the triangular lower parts of the filaments, and further protection is afforded by interlocking hairs that close the spaces between these five valves. The three short stylar branches are at first apposed to form a cylinder thickly clothed with long erect hairs, and so closely surrounded by the anthers in the

bud that these make up a continuous tube. As the anthers dehisce introrsely, the whole of the pollen is taken up by the stylar brush, which is then carried out of the anther-cylinder by the elongation of the style. The flower now opens, and the shrivelled stamens become retracted into its base, so that bees creeping into the corolla must come into contact with the pollen and gradually brush it away with their hairy coats. In the second stage of anthesis the stylar branches diverge and display their stigmatic inner surfaces, which now take up the position previously occupied by the pollen.

Crossing by means of insect visitors is ensured by this marked protandry, but in the absence of visitors automatic self-pollination is rendered possible by the bending back of the stylar branches.

Kerner points out that the bell-shaped corolla serves as a refuge to not a few insects. Some of the exotic species bear cleistogamous flowers, e. g. the East Indian forms C. canescens *Wall.* and C. colorata *Wall.* (H. von Mohl, Bot. Ztg., Leipzig, xxi, 1863, p. 315); and C. dimorphanta *Schweinf.*, native to Nubia and Upper Egypt.

O. Kirchner demonstrates (Jahreshefte Ver. Natk., Stuttgart, liii, 1897, p. 200) that there is a large amount of variation within the limits of the genus, in spite of the marked agreement between the various species as regards the mechanism, size, colour, and shape, as well as position and the way of aggregation into inflorescences. He groups the species which have so far been investigated in the following way (op. cit., pp. 214–15).—

A. Corolla-lobes spreading or reflexed: entrance to the flower open.

I. Entrance of the flower directed upwards.

1. Corolla wheel-shaped or basin-shaped, deeply incised.

a. Flowers solitary: C. cenisia *L.*

b. Flowers in racemes: C. garganica *Tenore*, C. Elatines *L.*, C. elatinoides *Moretti*.

2. Corolla funnel-shaped, bell-shaped, or tubular.

a. Style projecting from the corolla: flowers crowded.

(a) Flowers blue: C. Cervicaria *L.*, C. glomerata *L.*

(b) Flowers bright-yellow: C. thyrsoides *L.*, C. petraea *L.*

b. Style not projecting from the corolla.

(a) One-flowered.

Corolla bell-shaped: C. Morettiana *Reichb.*, C. Allionii *Vill.*, C. uniflora *L.*

Corolla funnel-shaped: C. Aucheri *A. DC.*, C. ciliata *Stev.*, C. spathulata *Ehrenb.*

(b) Few-flowered.

Flowers solitary in the axils.

Corolla funnel-shaped: C. libanotica *A. DC.*

Corolla bell-shaped: C. drabaefolia *Sibth. et Sm.*, C. cashmiriana *Royle.*

Flowers in racemes.

Flowers large: C. Rainerii *Perpent.*, C. carpatica *Jacq.*

Flowers small: C. Waldsteiniana *Roem. et Schult.*, C. pauciflora *Desf.*

(c) Numerous flowers arranged in racemes.

Corolla funnel-shaped: C. Rapunculus *L.*, C. patula *L.*, C. pyramidalis *L.*

Corolla bell-shaped: C. tomentosa *Vent.*, C. laciniata *L.*, C. Trachelium *L.*, C. Grossekii *Heuff.*, C. punctata *Lam.*, C. latifolia *L.*, C. lactiflora *Bieb.*

Corolla tubular: C. Celsii *A. DC.*

(d) Inflorescence a spike: C. spicata *L.*, C. multiflora *Waldst. et Kit.*

(e) Inflorescence a capitulum: C. lingulata *Waldst. et Kit.*

II. Entrance of the flower directed downwards.

1. Style straight.

a. One-flowered: C. pulla *L.*, C. excisa *Schleich.*

b. Flowers in racemes.

(a) Corolla bell-shaped and three stylar branches, corolla medium-sized: C. rotundifolia *L.*, C. Scheuchzeri *Vill.*, C. pusilla *Haenke*, C. caespitosa *Scop.*, C. carnica *Schiede.*

Five stylar branches, corolla large: C. Medium *L.*

(b) Corolla infundibulo-campanulate: C. sibirica *L.*, C. bononiensis *L.*, C. rapunculoides *L.*

(c) Corolla narrow funnel-shaped: C. Jaubertiana *Timb.*

2. Style bent: C. americana *L.*

B. Corolla-lobes inclined together so as to close the entrance of the flower: C. Zoysii *Wulf.*

1694. C. rotundifolia L. (Sprengel, 'Entd. Geh.,' pp. 109–12; Herm. Müller, 'Fertilisation,' p. 368, 'Alpenblumen,' p. 403; MacLeod, 'Bevruchtung der Bloemen,' p. 287; Kirchner, 'Flora v. Stuttgart,' p. 652; Knuth, 'Bl. u. Insekt. a. d. nodfr. Ins.,' pp. 100, 163, 'Blütenbiol. Notizen.')—The flowers of this species are mostly dull sky-blue in colour, though in some localities, e. g. the North Frisian Islands, they may vary from dark to whitish blue. They are pendulous and vary greatly in size. The white bases of the filaments act as nectar-guides. Autogamy can be effected by rolling back of the stylar branches should insect-visits fail. Warnstorf describes the pollen-grains as whitish in colour, spheroidal, closely beset with spinose tubercles, and about 31 μ in diameter.

The arctic variety *arctica* Lange usually bears a few large flowers on a stem 10–22 cm. high. The corolla is 21 mm. long and 34 mm. broad, and bright-blue in colour, though this may be replaced by white (var. *albiflora*).

Visitors.—The most prominent of these is the bee Melitta haemorrhoidalis *F.* which visits the flowers of the species throughout its entire range. Other very constant bee-guests in many parts of Europe are Eriades campanularum *K.* and Halictoides dentiventris *Nyl.*

Knuth observed the following.—

In the North Frisian Islands and at Kiel ('Bl. u. Insekt. a. d. nordfr. Ins., p. 163, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 237).—**A. Coleoptera.** 1. Miarus campanulae *L.*, numerous in the bases of the flowers. **B. Diptera.** (*a*) *Muscidae*. 2. Anthomyia sp.; 3. Sarcophaga carnaria *L.* (*b*) *Syrphidae*: 4. Eristalis arbustorum *L.*, po-dvg. **C. Hymenoptera.** *Apidae*: 5. Andrena shawella *K.* ♀; 6.

Apis mellifica *L.*; 7. Bombus derhamellus *K.* ♀; 8. B. lapidarius *L.* ♀; 9. B. sp.; 10. Halictus flavipes F. ♀; 11. Melitta haemorrhoidalis F. ♂. **D. Lepidoptera.** *Sphingidae*: 12. Zygaena filipendulae *L.*; (Rügen), the bee Melitta haemorrhoidalis *F.* ♂ and ♀; (Thuringia), 2 humble-bees—Bombus hypnorum *L.* ♂, and B. soroënsis *F.*, var. proteus *Gerst.* ♀.

Alfken observed the following bees at Bremen.—

Apidae: 1. Andrena gwynana *K.* ♀, 2nd gen.; 2. A. morawitzi *Ths.* ♂, 2nd gen.; 3. A. propinqua *Schenck* ♀, 2nd gen.; 4. Bombus agrorum *F.* ♂; 5. B. derhamellus *K.* ♂; 6. B. lapidarius *L.* ♀; 7. B. lucorum *L.* ♀ and ♂; 8. A. proteus *Gerst.* ♀ and ♀, skg. and po-cltg., ♂ skg.; 9. Dufourea vulgaris *Schenck* ♀ skg. and po-cltg. ♂ skg.; 10. Eriades campanularum *K.* ♀ and ♂; 11. E. nigricorius *Nyl.* ♀ and ♂; 12. Halictoides dentiventris *Nyl.* ♂; 13. H. inermis *Nyl.* ♂; 14. Megachile maritima *K.* ♀; 15. M. willughbiella *K.* ♀; 16. Melitta haemorrhoidalis *F.* ♀ and ♂; 17. Psithyrus rupestris *F.* ♂, skg.; 18. Stelis phaeoptera *K.* ♀, skg.

Herm. Müller (H. M.) for Sauerland (S.), Thuringia (T.) and Westphalia (W.), and Buddeberg (Budd.) for Nassau, record the following (Herm. Müller, 'Fertilisation,' p. 368, 'Weit. Beob.,' p. 77).—

A. Coleoptera. (*a*) *Curculionidae*: 1. Gymnetron campanulae *L.* (H. M.); 2. Otiorhynchus ovatus *L.* (H. M.). (*b*) *Staphylinidae*: 3. Anthobium (H. M.). **B. Diptera.** (*a*) *Bombyliidae*: 4. Systoechus sulphureus *Mikan*, skg. (H. M., S.). (*b*) *Empidae*: 5. Rhamphomyia plumipes *Fallen*, freq. (H. M.). (*c*) *Syrphidae*: 6. Melithreptus taeniatus *Mg.* (H. M., Bavarian Oberpfalz). **C. Hymenoptera.** (*a*) *Apidae*: 7. Andrena coitana *K.* ♂ (H. M., W. and Bavarian Oberpfalz); 8. A. gwynana *K.* ♂ (H. M., W., Budd.); 9. Apis mellifica *L.* ♀, skg. (H. M., W.); 10. Bombus lapidarius *L.* ♀, in large numbers, po-cltg. and skg. (H. M., Bavarian Oberpfalz); 11. B. pratorum *L.* ♀, skg. (H. M., W.); 12. Chelostoma campanularum *L.*, freq., skg. and po-cltg. (H. M., W.); 13. C. nigrocorne *Nyl.* ♀ and ♂, do. (H. M., W.); 14. Cilissa haemorrhoidalis *F.* ♀ and ♂, skg. and po-cltg. (H. M., W.); 15. Halictoides dentiventris *Nyl.* ♂ and ♀ (H. M., W.); 16. Halictus albipes *F.* ♀, skg. (Budd.); 17. H. smeathmanellus *K.* ♂ (H. M., W.); 18. Nomada furva *Pz.* (=N. minuta *F.* ♂) (H. M., T.). **D. Lepidoptera.** 19. Ino statices *L.* (H. M., S.).

The following were recorded by the observers, and for the localities stated.—

Wüstnei (Alsen), 2 bees—Cilissa haemorrhoidalis *F.*, and Osmia claviventris *Thoms.* (=O. interrupta *Schenck*). Sickmann (Osnabrück), the fossorial wasp Ammophila viatica *L. Dahlb.*, not rare. Friese (Mecklenburg), 8 bees—1. Andrena gwynana *K.*, 2nd gen.; 2. A. nigriceps *K.*, very rare; 3. A. shawella *K.*, not infrequent; 4. Eriades campanularum *K.*, do.; 5. E. nigricornis *Nyl.*, freq.; 6. Halictoides dentiventris *Nyl.*, do.; 7. H. inermis *Nyl.*, do.; 8. Melitta haemorrhoidalis *F.*, do. Schmiedeknecht and Friese (Thuringia), the bee Andrena curvungula *Thoms.* Schenck (Nassau), 2 bees—Halictoides dentiventris *Nyl.*, and Melitta haemorrhoidalis *F.* Loew (Riesengebirge) ('Beiträge,' p. 52), 2 bees—Bombus pratorum *L.* ♀, po-cltg., and Cilissa haemorrhoidalis *F.* ♀, skg. MacLeod (Flanders), 2 humble-bees and a small Muscid (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 441, vi, 1894, p. 374): (Pyrenees), a humble-bee, 2 Muscids, and 2 Empids (op. cit., iii, 1891, pp. 371–2). Herm. Müller (Alps), 9 bees (including Cilissa melanura *Nyl.*) and 3 Lepidoptera ('Alpenblumen,' p. 403). Morawitz (Tyrol) the bee Andrena alpina *Mor.* (also recorded by Schletterer and von Dalla Torre). E. D. Marquard (Cornwall), the bee Andrena albicrus *K.* Saunders and Smith (England), 2 bees—Eriades campanularum *K.*, and Melitta haemorrhoidalis *F.* Willis (in the neighbourhood of the south coast of Scotland) ('Fls. and Insects in Gt. Britain,' Part I).—**A. Coleoptera.** *Nitidulidae*: 1. Meligethes sp., freq., skg. **B. Diptera.** *Muscidae*: 2. Anthomyia radicum *L.*, freq., skg. **C. Hymenoptera.** *Apidae*: 3. Bombus terrester *L.*, do. **D. Lepi-**

doptera. *Rhopalocera*: 4. Vanessa urticae *L.*, skg. **E. Thysanoptera.** 5. Thrips, freq., skg. Scott-Elliott (Dumfriesshire), 2 humble-bees, a short-tongued bee, 3 Muscids, several Dolichopodids, a Lepidopterid, and the beetle Meligethes ('Flora of Dumfriesshire,' p. 110). Lindman (Dovrefjeld), on the var. *arctica* (with a corolla-tube up to 30 mm. long), a humble-bee, a beetle, a micro-Lepidopterid, and several flies.

1695. C. groenlandica Berl.—Kolderup and Rosenvinge consider that this reputed species is a variety of C. rotundifolia, belonging to the same series as *arctica* (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' pp. 62–3).

1696. C. caespitosa Scop. (Kirchner, Jahreshefte Ver. Natk., liii, 1897, p. 210.)—The flowers of this species are arranged in racemes or panicles. The corolla is bell-shaped and elongated (14–16 mm. long), broadest in the middle, and somewhat contracted under the lobes. It is bright-violet in colour with a reddish tinge, and marked internally with a distinct network of veins.

1697. C. pulla L. (Kirchner, op. cit.)—The large terminal flowers of this species are pendulous on short peduncles. The tube of the dark-blue bell-shaped corolla is 16 mm. long, while the lobes are 6 mm. in length, spreading, and tolerably straight. The entrance of the flower is 12 mm. broad. The style is 12 mm. long, and its branches do not recurve to form more than a semicircle, so that they do not reach the region to which pollen adheres.

1698. C. excisa Schleich. (Kirchner, op. cit.)—In this species the stem is erect, and the nodding flowers project horizontally from its end. The corolla is much smaller than that of C. pulla, and the curved shape of its incisions is characteristic.

1699. C. cenisia L. (Kirchner, op. cit., p. 201.)—Kirchner gives the following description of the flower mechanism of this species from the high Alps.—The flowers are solitary at the ends of short procumbent branches, and are directed vertically or obliquely upwards. The bright-blue corolla has a funnel-shaped tube 4 mm. long, and spreading apically reflexed lobes 10 mm. in length. The diameter of the flower above is 15–20 mm. The bright-blue style (10 mm. long) stands vertically in the middle of the flower, and projects somewhat beyond its entrance. At a later stage of anthesis its end divides into three (sometimes four) bright-yellow branches. The little drops of nectar secreted on the top of the ovary are completely covered by the broadened bluish-white bases of the filaments, which are fringed with woolly hairs. Automatic self-pollination does not take place, for though the stylar branches curve away from one another they do not become reflexed.

1700. C. pyramidalis L.—Kerner states that in the final stage of anthesis the stylar branches of this species curl back 1–1½ turns, so as to render automatic self-pollination possible.

1701. C. lingulata Waldst. et Kit. (=C. capitata Sims). (Kirchner, op. cit., p. 208.)—In this species the narrow funnel-shaped corolla is 35–40 mm. long, and the style does not project from it. The aid of particularly long-tongued insects appears to be necessary for pollination.

1702. C. Scheuchzeri Vill.—The corolla of this species is 25–30 mm. long.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 7 humble-bees, 2 other bees, and 3 Lepidoptera ('Alpenblumen,' pp. 403–4). Loew (Berlin Botanic Garden), a Muscid (Pyrellia cadaverina *L.*, resting on the outside of the corolla), and a bee (Apis mellifica *L.* ☿, skg. and po-cltg.).

1703. C. pusilla Haenke. (Kirchner, op. cit., p. 210.)—Kirchner says that the diverging stylar branches never become recurved, so that automatic self-pollination can only take place by the fall of pollen upon the edges of the stigmas, and as the flowers are pendulous this may sometimes happen.

Visitors.—Herm. Müller (Alps), 2 flies, 4 humble-bees, 4 other bees, and 2 Lepidoptera ('Alpenblumen,' p. 403).

1704. C. bononiensis L. (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Schulz, 'Beiträge.')—Warnstorf says that in this species the yellowish anthers generally shed their pollen on to the hairy style before the flower opens. Schulz states that the 3 (rarely 4) short stylar branches diverge early and, as they remain receptive and later on roll back spirally, often come into contact with the pollen that still clings to the outside of the style. Warnstorf describes the pollen-grains as whitish in colour, spheroidal, closely beset with low spinose tubercles, up to 44 μ in diameter.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Thuringia) ('Fertilisation,' p. 368, 'Weit. Beob.' III, p. 78).—**A. Coleoptera.** (*a*) *Curculionidae*: 1. Gymnetron campanulae *L.*, numerous. (*b*) *Nitidulidae*: 2. Meligethes, numerous. **B. Hymenoptera.** *Apidae*: 3. Chelostoma campanularum *K.* ♀ and ♂, freq.; 4. C. florisomne *L.* ♀ and ♂, in large numbers; 5. C. nigricorne *Nyl.* ♀ and ♂; 6. Cilissa haemorrhoidalis *F.* ♂; 7. Halictus flavipes *F.* ♀. von Dalla Torre (Tyrol), the humble-bee Bombus agrorum *F.* ♀ and ☿ (also recorded by Schletterer).

1705. C. rapunculoides L. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 362; Warnstorf, Verh. bot. Ver., Berlin, xxxix, 1896.)—Kerner states that the stylar branches of the pendulous flowers of this species roll back into spirals of over two turns. I have not been able to verify this in plants growing on the island of Föhr. Warnstorf, on the other hand, says that the stylar branches hardly describe a single turn when they roll back, so that in most cases the stigmas do not come into contact with the pollen clinging to the hairs on the style, and autogamy is therefore usually excluded. The pollen-grains are white in colour, spheroidal, closely beset with spinose tubercles, on the average about 50 μ in diameter.

Visitors.—Herm. Müller (H. M.) for Westphalia, and Buddeberg (Budd.) for Nassau give the following list (Herm. Müller, 'Fertilisation,' p. 368, 'Weit. Beob.,' III, p. 77).—

A. Diptera. *Syrphidae*: 1. Rhingia rostrata *L.*, skg., returning to the flowers with pollen on its back (H. M., Budd.). **B. Hymenoptera.** *Apidae*: 2. Andrena aestiva *Sm.* ♀ (Budd.); 3. A. gwynana *K.* ♂ and ♀ (H. M.); 4. Apis mellifica *L.* ☿, skg. (H. M.); 5. Bombus lapidarius *L.* ☿, skg. and po-cltg. (H. M.); 6. Chelostoma campanularum *K.* ♂ skg. (H. M., Budd.); 7. C. nigricorne *Nyl.* ♂ and ♀, numerous (H. M., Budd. ♂); 8. Cilissa haemorrhoidalis *F.* ♀ and ♂ (H. M.); 9. Halictus albipes *F.* ♀ (H. M.); 10. H. leucozonius *Schr.* ♀, skg. (H. M.); 11. H. maculatus *Sm.* ♂ (H. M.); 12. H. sexnotatus *K.* ♀, freq., skg. and po-cltg. (Budd.); 13. Prosopis communis *Nyl.* ♀ (Budd.); 14. P. hyalinata *Sm.* ♂ and ♀, numerous (H. M.).

The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), a humble-bee ('Alpenblumen,' p. 404). MacLeod (Pyrenees), 3 long-tongued bees (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 371). Schenck (Nassau), 2 bees—Halictoides dentiventris *Nyl.*, and Melitta haemorrhoidalis *F.*

1706. C. Trachelium L. (=C. urticifolia *Schmidt*).—Kerner states that the flowers of this species open at Innsbruck about 6–7 a.m., and close again about 6–7 p.m. He adds that the corolla is white in the neighbourhood of the Brenner, but blue in the eastern Limestone Alps. The stylar branches curve back in a crescentic manner, and effect autogamy by coming into contact with the pollen adhering to the hairs of the corolla if crossing has not already been brought about by insects. Warnstorf says that the branches roll back until they touch the pollen remaining on the style. The pollen-grains are yellow in colour, spheroidal, beset with spinose tubercles, about 47 μ in diameter.

Visitors.—Herm. Müller (H. M.) ('Fertilisation,' p. 368, 'Weit. Beob.' III, p. 77) and Knuth (Kn.) ('Bloemenbiol. Bijdragen') observed the following.—

A. Coleoptera. (*a*) *Cryptophagidae*: 1. Antherophagus sp. (H. M.). (*b*) *Curculionidae*: 2. Gymnetron campanulae *L.* (H. M., Thuringia). (*c*) *Nitidulidae*: 3. Meligethes, in very large numbers (H. M.). **B. Diptera.** *Syrphidae*: 4. Chrysochlamys ruficornis *F.*, po-dvg. (H. M.); 5. Rhingia rostrata *L.*, skg. (Kn.); 6. Syrphus balteatus *Deg.*, po-dvg. (H. M.). **C. Hymenoptera.** *Apidae*: 7. Andrena coitana *K.* ♀ and ♂, the ♂ very common (H. M.); 8. A. fulvicrus *K.* ♂ (H. M.); 9. A. gwynana *K.* ♀ and ♂, freq. (H. M.); 10. Apis mellifica *L.* ☿, skg. (Kn., H. M.); 11. Bombus lapidarius *L.* ☿, po-cltg. (Kn., H. M.); 12. Chelostoma campanularum *L.* (H. M.); 13. C. nigricorne *Nyl.* ♂, skg. (H. M.); 14. Cilissa haemorrhoidalis *F.* ♀ and ♂, skg. and po-cltg., ♂ very common (Kn., H. M.); 15. Halictoides dentiventris *Nyl.* ♀ and ♂, ♂ very common (H. M.); 16. Halictus cylindricus *F.* ♀, po-cltg. (H. M.); 17. Prosopis halinata *Sm.* ♀ and ♂, numerous (H. M.); 18. Xylocopa violacea *L.* ♀, skg. (H. M., Wurzburg).

The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), a humble-bee ('Alpenblumen,' p. 404). Schletterer and von Dalla Torre (Tyrol), the bee Halictus costulatus *Krchb.* Wüstnei (Alsen), the bee Cilissa haemorrhoidalis *F.* Sickmann (Osnabrück), the fossorial wasp Crabro chrysostomus *Lep.* Krieger (Leipzig), 5 bees—1. Eriades nigricornis *Nyl.*; 2. Halictus morio *F.*; 3. H. smeathmanellus *K.*; 4. Melitta haemorrhoidalis *F.*; 5. Trachusa serratulae *Pz.* Schmiedeknecht (Thuringia), 3 bees—1. Andrena alpina *Mor.*; 2. A. gwynana *K.*, 2nd gen.; 3. A. shawella *K.* Schenck (Nassau), the bee Halictoides dentiventris *Nyl.*

1707. C. sibirica L. (Kirchner, Jahreshefte Ver. Natk., Stuttgart, liii, 1897, p. 211.)—The numerous flowers of this species are arranged in panicles. The calyx-teeth are 7–8 mm. long, and perpendicular to the corolla, while the bracteoles which alternate with them are reflexed. The violet corolla is 28–30 mm. in length, of which 8–10 mm. are taken up by its lobes. The style is equal in length to the corolla-tube, and its branches ultimately roll back into spirals of two turns, so that automatic self-pollination can take place.

Visitors.—Kirchner observed a bee, of which the species was not determined.

1708. C. Erinus L. (Kirchner, op. cit., p. 204.)—Kirchner investigated plants of this species in the Hohenheim Botanic Garden, and gives the following description of the flower mechanism.—

The flowers are small and situated at the origins of the branches. The foliose calyx-teeth are as long as the corolla, which is cylindrical in shape with a widened base, 6–7 mm. long and 3 mm. broad. Its colour is bluish-white with a bright-blue limb. The five (sometimes only four) corolla-lobes are 2 mm. in length and somewhat spreading, so that the flower is about 5 mm. broad above. As the style is 4 mm. long, its three branches spread out at the entrance of the flower. The dehiscence of the bright-yellow anthers, and the secretion and protection of nectar are effected as usual. In spite of the small size of the flowers automatic self-pollination does not appear to take place.

Visitors.—Kirchner observed the honey-bee.

1709. C. Rapunculus L. (Kirchner, 'Flora v. Stuttgart,' p. 653.)—The conspicuous panicle of this species bears numerous flowers with blue funnel-shaped corollas 20–5 mm. long, and pointed lobes 7–9 mm. in length. Towards the end of anthesis the stylar branches roll back into spirals of 1–1½ turns, so that automatic self-pollination can be effected should insect-visits fail.

Visitors.—Knuth observed the honey-bee and the humble-bee Bombus lapidarius *L.* ☿, both creeping right into the flowers, skg. and po-cltg. Schenck (Nassau) saw the dasygastrid bee Eriades campanularum *K.*

1710. C. persicifolia L.—Kerner says that the stylar branches of this species roll back into spirals of 1½–2 turns. Warnstorf, on the other hand, states that at a late stage they simply diverge, but do not become reflexed, so that autogamy is excluded. The pollen-grains are yellowish-white in colour, spheroidal, beset with small spinose tubercles, 31–5 μ in diameter.

Visitors.—Herm. Müller (H. M.) for Westphalia and Thuringia, and Buddeberg (Budd.) for Nassau, give the following list (Herm. Müller, 'Fertilisation,' p. 369, 'Weit. Beob.,' III, p. 78).—

A. Coleoptera. (*a*) *Curculionidae*: 1. Gymnetron campanulae *L.*, freq. (H. M., Thuringia). (*b*) *Nitidulidae*: 2. Meligethes sp., freq. (H. M., Thuringia). **B. Hymenoptera.** *Apidae*: 3. Chelostoma campanularum *L.*, ♂ and ♀, po-cltg. and skg. (H. M., Thuringia); 4. C. nigricorne *Nyl.* ♂ and ♀, skg. (H. M., Thuringia, Budd.); 5. Prosopis communis *Nyl.* ♀ (Budd.); 6. P. confusa *Nyl.* ♂ (Budd.); 7. P. hyalinata *Sm.* ♂ and ♀ (H. M., Westphalia). **C. Orthoptera.** 8. Forticula auricularia *L.* (H. M., Westphalia). **D. Thysanoptera.** 9. Thripus, numerous (H. M., Thuringia).

The following were recorded by the observers, and for the localities stated.—

Schmiedeknecht (Thuringia), the bee Andrena gwynana *K.*, 2nd gen. Alfken (Bremen), the bee Eriades nigricornis *Nyl.* ♀, skg. Knuth (Rügen), 2 bees (Andrena gwynana *K.* ♀, summer gen., and Eriades nigricornis *Nyl.* ♀). Loew (Silesia), 2 bees in the bases of the flowers—Dasytes niger *L.*, nect-lkg., and Halictoides dentiventris *Nyl.* ♂ ('Beiträge,' pp. 34, 51). Schletterer (Tyrol), 2 bees—Colletes balteatus *Nyl.*, and Megachile (Chalicodoma) pyrenaica *Lep.* ♀. The latter is also recorded by von Dalla Torre.

1711. C. thyrsoides L. (Herm. Müller, 'Alpenblumen,' pp. 405–6.)—In this species the corolla-lobes and style are covered with hairs 3–5 mm. long, apparently as a protection against small creeping insects. Automatic self-pollination is undoubtedly excluded.

Visitors.—Herm. Müller observed 3 Hymenoptera, 3 Lepidoptera, and a fly.

1712. C. Cervicaria L.—Kerner states that the flowers of this species remain in a vertical position.

1713. C. glomerata L.—The flowers of this species remain vertical, and Kerner says that they open periodically.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Schenck (Weilburg), 5 bees (Herm. Müller, 'Weit. Beob.,' III, p. 78), 5 bees—1. Andrena curvungula *Thoms.*, visiting this species only and collecting an enormous amount of pollen, loading itself more than any other Andrena; 2. Apis mellifica *L.* ☿; 3. Ceratina coerulea *K.*; 4. Coelioxys quadridentata *L.*; 5. Heriades campanularum *L.*: (Nassau), 2 bees—Andrena curvungula *Ths.*, and Osmia papaveris *Ltr.* Schletterer and von Dalla Torre (Tyrol), 3 bees—1. Halictus quadricinctus *F.* ♀; 2. H. sexnotatus *K.* ♀; 3. Osmia adunca *Ltr.* ♀, very common. Loew (Berlin Botanic Garden), a hover-fly (Pipiza bimaculata *Mg.*, po-dvg.) and a bee (Chelostoma nigricorne *Nyl.* ♂, skg., and creeping right into the flowers).

1714. C. barbata L. (Herm. Müller, 'Alpenblumen,' pp. 404–5.)—There are hairs 3–5 mm. long on the corolla-lobes of this species, which serve as a protection against creeping animals. Hermann Müller says that automatic self-pollination is rendered possible by the bending back of the stylar branches, which become twisted into spirals of 1–1½ turns.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), a beetle, 2 flies, 11 Hymenoptera, and 4 Lepidoptera. Ricca (Atti Soc. ital. sc. nat., Milano, xiv, 1871) (Alps), humble-bees up to a height of 2600 m. Schletterer and von Dalla Torre (Tyrol), the humble-bee Bombus soroënsis *F.* Loew (Altvatergebirge) ('Beiträge,' p. 52), a Curculionid beetle (Gymnetron campanulae *L.*) and 2 bees (Bombus lapidarius *L.* ♂, skg., and B. soroënsis *F.* ♀ and ☿, skg.).

1715. C. Medium L. (Ludwig, Bot. Centralbl., Cassel, xviii, 1884, p. 145.)—In this species Ludwig saw flies (especially Empis aestiva *Loew*) adhering to the style, and supposes that the sticky nature of this is a protection against unbidden guests of the kind.

Visitors.—Delpino observed beetles (Cetonia sp.) ('Ult. oss.,' I, 2, p. 30).

1716. C. spicata L. (Kirchner, 'Beiträge,' p. 59.)—The flowers of this species are aggregated into long conspicuous spikes. Kirchner examined them at Zermatt and found their mechanism to be the same as in related forms. The corolla is bright-violet in colour, whitish at the base, and gradually widening into a funnel 30 mm. long, the direction of which is continued by its lobes (12 mm. in length). Towards the end of anthesis the three stylar branches roll back into spirals of 2 turns, so that, as Kerner pointed out, automatic self-pollination is possible should insect-visits fail.

1717. C. uniflora L. (Warming, 'Bestövningsmaade,' pp. 52–4.)—Warming describes the flowers of this northern species as dark-blue in colour, and either vertical or nodding. The style projects but little, and as the anthers dehisce and the stigmas become receptive in the bud, the latter are pseudo-cleistogamously self-

pollinated, and many of the pollen-grains germinate upon them. Later on the flowers open in a normal manner, passing from cleistogamy to chasmogamy, a unique occurrence so far as yet known.

Vanhöffen collected ripe fruits in Greenland (27. 7. '93) (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' pp. 61–2). The species is very rare in Spitzbergen and has only once been observed in flower there (10. 8. '68) (Andersson & Hesselman, 'Bidrag till Känned. om Spetsbergens o. Beeren Eil. Kärlväxtflora,' p. 16).

1718. C. latifolia L.—In this species the corolla-tube is 35 mm. long.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth, the honey-bee, skg., creeping right into the flowers, and coming out again covered with pollen. Loew (Berlin Botanic Garden), 2 bees, creeping completely into the flowers—Apis mellifica *L.* ☿, skg. and po-cltg., and Bombus pratorum *L.* ☿: on the var. *serotina*, the bee Chelostoma nigricorne *Nyl.* ♀, skg., and creeping right into the flowers. Scott-Elliot (Dumfriesshire), a humble-bee ('Flora of Dumfriesshire,' p. 109).

1719. C. patula L.—Kerner says that the stylar branches of this species roll into spirals of more than 2 turns, and that the flowers hang down during inclement weather. Warnstorf describes the pollen-grains as white in colour, spheroidal, beset with numerous spinose tubercles, 25–31 μ in diameter.

Visitors.—The following were recorded by the observers, and for the localities stated.—

MacLeod (Belgium), a bee (Chelostoma sp.) and a butterfly (Pieris sp.) (Bot. Jaarb. Dodonaea, Ghent, v. 1893, p. 441): (Pyrenees), 2 Muscids (op. cit., iii, 1891, p. 371). Herm. Müller (Westphalia, Thuringia, and the Bavaraian Oberpfalz), 7 bees—1. Andrena coitana *K.* ♀ (Oberpfalz); 2. A. gwynana *K.* ♀ and ♂, skg. and po-cltg.; 3. A. labialis *K.* ♂, skg. (Jena); 4. Chelostoma nigricorne *Nyl.* ♂ and ♀, skg. and po-cltg.; 5. Cilissa haemorrhoidalis *K.* ♂ and ♀, do. (Oberpfalz); 6. Halictoides dentiventris *Nyl.* ♂ and ♀, skg. (Lower Franconia); 7. Rophites quinquespinosus *Spin.* ♂, do. (Oberpfalz). Alfken (Bremen), 2 bees—Eriades nigricornis *Nyl.* ♀ and ♂, and E. truncorum *L.* ♀, skg. Schmiedeknecht (Thuringia) and Krieger (Leipzig), the bee Andrena curvungula *Thoms.*; Schletterer and von Dalla Torre (Tyrol), 2 bees—Halictus levigatus *K.* ♀ (=H. lugubris *K.*), and Osmia leucomelaena *K.* ♀ and ♂.

1720. C. carpatica Jacq. (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The stylar branches of this species are extremely long. During the female stage of anthesis they either simply diverge or curve slightly back, but never roll up, so that autogamy is undoubtedly excluded. Darwin states that the species is self-sterile. The pollen-grains are greyish-green in colour, beset with spinose tubercles, on the average 37 μ in diameter.

Visitors.—Loew observed the following bees in the Berlin Botanic Garden.—

1. Apis mellifica *L.* ☿, skg. and po-cltg.; 2. Chelostoma campanularum *K.* ♀, creeping right into the flowers and skg.; 3. C. nigricorne *Nyl.* ♀, do., also po-cltg.; 4. Megachile lagopoda *L.* ♀, creeping into the flowers, skg. and po-cltg.; 5. Prosopis communis *Nyl.* ♀.

1721. C. Zoysii Wulf. (Kirchner, Jahreshefte Ver. Natk., Stuttgart, liii, 1897, pp. 213–14.)—Kirchner investigated this species in the Hohenheim Botanic Garden, and says that the flowers are borne singly on the low upright stem or its branches. They are directed obliquely downwards. The bright-blue corolla is 16–18 mm. long, and its tube is of truncated conical shape, 12 mm. in length and 8–9 mm. broad at the base, gradually tapering to 4½ mm. The five corolla-lobes are bent inwards so that their tips and edges touch, the opening of the flower being thus completely closed. Between each pair of lobes the corolla is thrown into a triangular external fold, so that the narrow part of the tube has a sort of five-sided pyramid surrounding it, of which the base is 6–7 mm. broad and the height about 6 mm. The corolla-lobes are beset with white hairs, which help to close the spaces between their edges, though they can be easily separated, e. g. by the head of an insect searching for nectar. The strong white style is 16 mm. long, and its base is surrounded by an orange-red nectary. When mature its end is sharply bent almost at right angles, so that it remains enclosed in the corolla. When the bud is some 10 mm. long the style is about 8 mm., and is closely surrounded by the five stamens, which are of the same length. The bright-yellow anthers dehisce introrsely, and their similarly-coloured pollen thickly covers the hairs which invest the capitate thickening formed by the apposition of the three short stylar branches. The anthers then shrivel and are retracted into the base of the flower, while the style elongates, and its end becomes bent. Ultimately the stylar branches diverge, but automatic self-pollination does not seem to take place.

Visitors.—Kirchner only noticed Thrips.

1722. C. lactiflora Bieb.—

Visitors.—Loew (Berlin Botanic Garden) observed the bee Prosopis communis *Nyl.* creeping into the flowers.

1723. C. Hostii Baumg.—

Visitors.—As No. 1722.

1724. C. rhomboidalis L.—

Visitors.—Loew (Berlin Botanic Garden) observed the bee Chelostoma nigricorne *Nyl.* ♀, creeping right into the flowers, skg. and po-cltg.

511. Symphyandra A. DC.

Kirchner says (Jahreshefte Ver. Natk., Stuttgart, liii, 1897, p. 215) that this genus only differs from Campanula in the lateral union of the anthers to form a tube through which the style grows, taking up pollen on its sweeping-hairs as it does so.

512. Specularia Heist.

Flowers protandrous with concealed nectar. Corolla wheel-shaped. Mechanism as in Campanula. In the first stage of anthesis pollen is shed on the stylar hairs, and the stigmas unfold during the second. Cleistogamous flowers are sometimes present, and this is the case in all the American species.

1725. S. Speculum A. DC. (=Campanula Speculum *L.*). (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 116.)—Kerner says that the violet flowers of this species

open about 7–8 a. m., and close again about 3–4 p. m. During closing the wheel-shaped corolla is thrown into longitudinal folds, which take up some of the pollen, transferring this to the open stigmas when closing next takes place. The anthers dehisce as soon as the bud opens. During this first stage of anthesis insect visitors use the pollen-covered style as an alighting-place, so that their ventral surfaces get dusted. Should they now visit a flower in the second stage they will transfer this pollen to the expanded stigmas on which they settle. Kerner says that before the blossoms wither the stylar branches become so strongly recurved that their inner papillose surfaces reach the end of the style and pollinate themselves automatically with the grains that remain clinging to this. Autogamy can therefore be effected in one of two ways, i. e. by the folded corolla when it shuts up, and by the reflexed stylar branches. Kirchner found that nectar was but sparsely secreted by flowers in the South Tyrol and the Hohenheim Botanic Garden, even when the weather was sunny (Jahreshefte Ver. Natk., Stuttgart, liii, 1897, p. 196).

Cleistogamous flowers have been observed, as e. g. by Kirchner (op. cit.) in all the plants growing in the Hohenheim Botanic Garden, which had been grown from seeds sent from the Paris Botanic Garden. They resemble the similar flowers of the next species.

Visitors.—Schletterer (Pola) observed 3 bees—1. Halictus quadrinotatus *K.*; 2. H. variipes *Mor.*; 3. H. vestitus *Mor.*

1726. S. perfoliata A. DC.—This species bears cleistogamous flowers, which were known to Linnaeus, and were carefully described by H. von Mohl in 1863 (*cf.* Vol. I, pp. 53–4).

1727. S. hybrida A. DC. (Kirchner, op. cit., pp. 196–7.)—Kirchner examined plants of this species in the Hohenheim Botanic Garden, and found the flower mechanism to be quite similar to that of S. Speculum, except that the flowers are much smaller. The corolla projects vertically between the five long calyx-teeth, and broadens into a funnel of which the base is $5\frac{1}{2}$ mm. in diameter. It is lilac in colour, passing into bright greenish-yellow at the base, and its lobes ($2\frac{1}{2}$ mm. long) are marked with a darker median line. When the flower opens the five blue or bright-yellow anthers dehisce, and deposit their bright-yellow pollen on the style they surround closely. They now shrivel up to some extent and become retracted from the style, the three stigmatic branches of which quickly diverge and curve downwards. The flowers close in the evening in the same way as those of S. Speculum. Kirchner observed some tetramerous flowers, and also some in which the diameter of the corolla was only 3 mm., but the mechanism of these was the same as that of normal ones.

513. Adenophora Fisch.

Kirchner (Jahreshefte Ver. Natk., Stuttgart, lii, 1897, pp. 215–16) calls attention to the epigynous nectar-secreting disk, the margin of which is swollen into a ring, so that the base of the style is surrounded by a 'nectar-collar' as in Compositae.

1728. A. communis Fisch. (=A. lilifolia *Ledeb.*). (Kirchner, op. cit.)—Kirchner has investigated plants of this species cultivated in the Hohenheim Botanic Garden, where the flowers are bright-blue or bluish-white in colour, smell like narcissus, and

are arranged in a loose raceme, of which the individual blossoms are pendulous and borne on long pedicels directed obliquely upwards. The lobes of the calyx are reflexed, small, green, and possess a few glandular teeth. The corolla is bell-shaped, resembling that of Campanula rotundifolia, with a maximum diameter of about 12 mm.: its tube is 10 mm. and its five triangular recurved lobes 6 mm. in length. The filaments are white in colour and covered with woolly hairs: the edges of their broadened bases are close together and connected by the interlocking of their hairs. The anthers are bright-yellow. The base of the style is surrounded by a white 'nectar-collar' 2 mm. high and $1\frac{1}{2}$ mm. deep, the cavity of which is filled with nectar, droplets of this being also secreted by its outer surface. The style ultimately attains the length of 24 mm., and projects far out of the corolla. Its basal end is white and its terminal portion blue in colour, and there is a gradual increase in thickness from the former to the latter. The three white stigmatic branches curve away from one another. The protandrous mechanism agrees with that of Campanula. Shortly before the flower opens the anthers shed their pollen upon the stylar hairs, and the stamens then become retracted. The stylar branches ultimately bend back so far that their tips touch the style.

1729. A. verticillata Fisch.; **1730. A. stylosa** Fisch.; **1731. A. periplocaefolia** A. DC.; **1732. A. marsupiiflora** Fisch. (=A. coronata *A. DC.*; and **1733. A. Lamarkii** Fisch.—These species have not been investigated in detail, but Kirchner (op. cit.) states that their flower mechanism essentially agrees with that of A. communis. They present differences in the way of branching and number of flowers of the inflorescences, as well as in the size and shape of the corolla. This may be bell-shaped or funnel-shaped, while in the case of A. verticillata it is tubulo-campanulate and only 9 mm. long. In several species (e. g. A. verticillata, A. stylosa, A. periplocaefolia, and A. marsupiiflora) the style projects from the corolla as in A. communis, but in the rest it is of the same length as the corolla or sometimes shorter. The nectar-collar is particularly long in A. marsupiiflora, being a cylinder 7 mm. long with a toothed and hairy margin. In A. Lamarkii and A. stylosa it is of the same length as in A. communis, and in other species shorter.

Visitors.—Loew (Berlin Botanic Garden) observed 2 hover-flies on A. stylosa (Melanostoma mellina *L.*, outside the flowers, and Platycheirus scutatus, po-dvg.).

514. Trachelium Tourn.

Protandrous Lepidopterid flowers. Delpino ('Ult. oss.,' pp. 71–4) and Hildebrand (Bot. Ztg., Leipzig, xxviii, 1870, p. 624) describe the species of this genus as markedly protandrous. In the first stage of anthesis the pollen clings to the hairy thickened end of the style, which has grown up between the anthers in the bud and taken it up. As the hairs wither the pollen is easily removed by insect visitors. In the last stage of anthesis the papillose stigma is developed.

1734. T. caeruleum L. (Kirchner, Jahreshefte Ver. Natk., Stuttgart, liii, 1897, pp. 217–18; Delpino, 'Ult. oss.,' I, 2, pp. 22 et seq.)—Kirchner and Delpino give the following account of the flower mechanism.—

Although the flowers are small compared to those of Campanula they are vertical and associated together in a flat-topped cyme of considerable size, the conspicuous-

ness of which is enhanced by their blue colour. The delicate narrow epigynous corolla (4–6 mm. long) has a funnel-shaped limb and a relatively long and very narrow tube. Before the flower opens the throat of the corolla is completely filled by the five anthers, which are borne on slender filaments. The end of the style is capitate, and beset with erect, mostly unicellular, hairs swollen at their bases. At this stage it is below the whorl of anthers. The style now quickly elongates, and presses strongly against the dehiscing anthers, the resistance of which being too great for it to overcome often causes it to be thrown into a curve. Still further elongation throws the style into a state of increased tension, which is finally relieved by the opening of the corolla. The end of the style now suddenly forces its way through the anthers, carrying off the pollen on its hairs, and protrudes for a considerable distance from the entrance of the flower. At first the pollen adheres so closely to the sweeping-hairs that it cannot be removed by stroking with the fingers, but very soon these hairs begin to contract at their bases so that the pollen can be easily detached. This is usually effected by insect visitors, and proliferation of the stigmatic tissue at the end of the style now begins, causing this to split and develop into an obscurely 3-lobed stigma, which ultimately develops into three very short white stigmatic branches. As by this time all the pollen of the flower has been removed, crossing by insect visitors is the only possible means of fertilization, for automatic self-pollination is out of the question. The individual flowers of an inflorescence are in different stages of anthesis, though the stage in which pollen is present lasts for a much shorter time than that during which the stigmas are receptive. The semi-transparent corolla-tube is half full of nectar, which is sucked by insect visitors. The interesting specializations in which Trachelium differs from Campanula and similar genera are the following.—

Sweeping away of the pollen from the dehisced anthers by means of sweeping-hairs on the end of the style. Successive protrusion of pollen and stigma outside the flower. Reduction in size and narrowing of the corolla, with nectar concealed in a tube only accessible to butterflies, the proboscis of which is at the same time guided to it. Aggregation of very numerous small flowers into a flat-topped inflorescence, enabling many of them to be visited and pollinated in a short time. These adaptations obviously make crossing by insects so certain that the species can well afford to dispense with the possibility of automatic self-pollination.

Visitors.—Delpino observed butterflies (various sp. of Pieris, skg.), and a small bee (Halictus sp., po-cltg.).

515. Wahlenbergia Schrad.

This agrees with Campanula, but Schönland says that the pollen-grains on the style are held fast by the secretion of a sticky fluid.

1735. W. hederacea Reichb. (Willis and Burkill, 'Fls. and Insects in Gt. Britain,' Part I, p. 263.)—Willis and Burkill have investigated this species in Central Wales, and describe the corolla of the erect tubulo-campanulate flower as about 10 mm. long, with an opening 3–4 mm. wide. It is odourless, and pale-blue in colour, traversed by darker veins. The stamens do not possess the broad base and slender distal region seen in the species of Campanula, but the filaments gradually

broaden from apex to base, the latter being hairy. The flower mechanism is like that of Campanula, but only the anthers wither after the pollen has been shed on the style, the filaments persisting as nectar-covers. Crossing is secured by insect-visits, but automatic self-pollination is possible should these fail, for the stigmatic branches ultimately bend so far back that they touch the pollen clinging to their own style.

Visitors.—Willis and Burkill observed 2 Muscids, of which one was sufficiently large to remove pollen from the style: also Thrips, and a bug which crept into the flowers.

1736. **W. tenuifolia** A. DC. (=Hedraeanthus tenuifolius *A. DC.*). (Kirchner, Jahreshefte Ver. Natk., Stuttgart, liii, 1897, p. 217.)—Kirchner has examined plants of this species in the Hohenheim Botanic Garden, and says that their protandrous mechanism agrees essentially with that of Campanula. The bright blue flowers are arranged in large terminal heads. The style is as long as the corolla, and its end divides into two stigmatic branches which become recurved, though not sufficiently to touch the style with their tips, so that automatic self-pollination is apparently excluded.

Visitors.—Kirchner observed the honey-bee.

516. Phyteuma L.

Literature.—Sprengel, 'Entd. Geh.,' pp. 113–15; Herm. Müller, 'Alpenblumen,' pp. 406–9.

Flowers protandrous, and belonging to class **S.**

In this genus (and Jasione, *q. v.*) the end of the style is at first covered with closely set erect hairs, as in Campanula, and these receive the pollen which is dehisced in the bud. As in Compositae this is swept out of a tube by the elongating style, but in this case the tube is not made up of the anthers but of the long strap-shaped corolla-lobes, which are at first closely apposed. After dehiscence the stamens contract into a crumpled mass. The lower free parts of the corolla-lobes bend somewhat outwards, so that their upper parts can be drawn down. As meanwhile the style elongates, the pollen is not merely pushed up by the stylar brush, but entirely swept out of the tube which surrounds it.

When the growing tip of the style has reached the upper end of the tube made up by the ends of the corolla-lobes, the three until now closely apposed stylar branches begin to separate, and rupture the tube (already split below), so that this glides down the style. The branches then quickly diverge until their papillose inner surfaces occupy the place where the pollen masses were heaped up during the first stage of anthesis. As the insect visitors (bees and humble-bees) creep over the inflorescences from below upwards, they not only, like all other visitors, regularly cross the older flowers with the pollen of the younger, but also, owing to the fact that anthesis progresses from below upwards, constantly effect crossing between different stocks.

Should insect-visits be prevented by unfavourable weather, Kerner says that the stylar branches roll back until they touch the pollen still clinging to the stylar hairs, thus effecting automatic self-pollination.

Conspicuousness is greatly enhanced by aggregation of the usually blue or violet flowers into rounded, ovoid, or elongated heads, and the frequency of insect-visits is generally proportional to the size of the heads.

Kirchner (Jahreshefte Ver. Natk., Stuttgart, liii, 1897, pp. 219–20) has emphasized the fact that the above description, abstracted from Hermann Müller, only applies to species belonging to the section Hedranthum *G. Don*, in which the flowers are sessile and the corolla-lobes gradually become separate from base to tip in the course of anthesis. The flowers of the section Synotoma *G. Don* are also social.

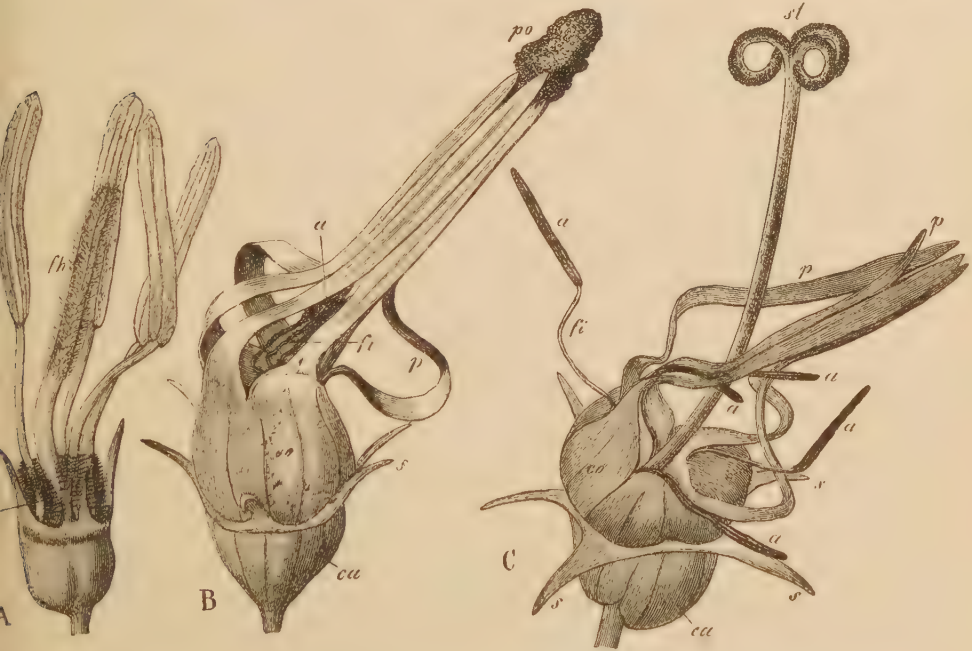


FIG. 213. *Phyteuma*, *L.* (after Herm. Müller). *A*. Young flower-bud of Phyteuma Michelii, after removal of the corolla and one stamen. *B*. Flower in the first (male) stage. *C*. Ditto, in the second (female) stage (× 7). *a*, anthers; *ca*, calyx; *co*, corolla; *fh*, stylar brush (sweeping-hairs); *fi*, filaments; *p*, corolla-lobes; *po*, pollen; *s*, teeth of calyx; *sd*, nectar-covers; *st*, stigmas.

In the sub-genera Podanthum *Boiss.*, Petromarula *Vent.*, and Cylindrocarpa *Regel*, the inflorescences are panicles or racemes, so that their flowers differ very essentially in form and mechanism from those which are more closely associated. This is the case, for instance, with the next species.

1737. P. canescens Waldst. et Kit. (Kirchner, op. cit., pp. 219–20.)—This species belongs to the section Podanthum. Kirchner has investigated it in the Hohenheim Botanic Garden. The flowers are arranged in a long loose raceme, and their mechanism is closely related to that of Campanula. The calyx-teeth are green in colour, subulate, and 5 mm. in length. The five (sometimes four) petals are 10–15 mm. long, and 2–2½ mm. broad, and scarcely united at their bases. They diverge almost in the same plane to form a star about 20 mm. in diameter, and are violet in colour with a whitish base, and traversed by a darker median streak. The

five grey anthers are 6 mm. long and borne on bluish-white filaments, 3 mm. long and broadened at their bases. They dehisce when the bud is fully mature and deposit their grey pollen on the hairs covering the style. In the open flower the stamens have shrivelled, and the pollen-laden style (10–12 mm. long) projects, its branches being at first apposed. Later on, when most of the pollen has been removed, the three stylar branches diverge, and ultimately roll back until they touch the style, coming into contact with any grains that may be left, so that automatic self-pollination is possible. Nectar is secreted in the base of the flower round the insertion of the style.

Visitors.—Delpino observed numerous Hymenoptera, and Loew (Berlin Botanic Garden) saw a hover-fly (Syrphus balteatus *Deg.*) and Apis, skg.

1738. **P. limoniifolium** Sibth. et Sm., and 1739. **P. campanuloides** Bieb. (Kirchner, op. cit.)—These species resemble P. canescens in their inflorescences, flowers, and no doubt their mechanism, but the blossoms of P. limoniifolium are smaller.

The following species belong to the sub-genus Hedranthum (flower class **S**).

1739. **P. Michelii** All. (= P. betonicaefolium *Vill.*). Kirchner, Jahreshefte Ver. Natk., Stuttgart, liii, 1897, p. 233.—In this species there are about 100 flowers in a head. Kirchner noticed (at Locarno) that at the end of anthesis the three stylar branches roll back into circles, but do not usually reach the style, upon which indeed no pollen as a rule remains. Automatic self-pollination can therefore only take place very rarely, and insect-visits are so numerous that it is almost always unnecessary.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Switzerland), a beetle, 8 flies, 17 bees, and 42 Lepidoptera ('Alpenblumen,' p. 411). Loew (Switzerland), 2 bees (Bombus rajellus *K.* ☿, skg., and Megachile analis *Nyl.* ♀, po-cltg.) and an undetermined Noctuid ('Beiträge,' p. 59). MacLeod (Pyrenees), 2 humble-bees, a hover-fly, and a Muscid ('Pyreneënbl.,' p. 371).

1740. **P. spicatum** L.—In this species the head is made up of about 100 flowers, yellowish-white in colour with a green tip, and smelling faintly of vanilla. Kerner says that automatic self-pollination ultimately becomes possible by rolling back of the stylar branches.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (on the Inselsberge in Thuringia, 16. 7. '94), 4 bees, skg.—1. Apis mellifica *L.* ☿; 2. Bombus agrorum *F.* ♀; 3. B. lapidarius *L.* ♀ and ♂; 4. B. pratorum *L.* ♂ ('Bloemenbiol. Bijdragen'). Herm. Müller (Teutoburger Wald), an Elaterid beetle (Agriotes palliduus *Ill.*?), a Nitidulid beetle (Meligethes aeneus *F.*), a Staphylinid beetle (Anthobium sorbi *Gyll.*, exceedingly numerous), and a bee (Apis mellifica *L.* ☿, skg.) ('Weit. Beob.' III, p. 78). Alfken (Bremen), 2 humble-bees—Bombus proteus *Gerst.*, and B. agrorum *F.*

1741. **P. nigrum** F. W. Schmidt. (Kirchner, 'Flora v. Stuttgart,' p. 651.)—The heads of this species contain about 40 flowers of dark-blue colour. Kirchner says the pollen is dark-red.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Westphalia), the humble-bee Bombus lapidarius *L.* ♀, skg. ('Bloemenbiol. Bijdragen'). Buddeberg (Nassau), a hover-fly (Rhingia rostrata *L.*, skg.) and 5 bees —1. Andrena convexiuscula *K.* ♀, skg.; 2. A. hirtipes *Schenck* ♀, skg.; 3. Halictus malachurus *K.* ♀, in large numbers, skg. and po-cltg.; 4. H. tetrazonius *Klg.* (=H. quadricinctus *K.*) ♀, skg.; 5. H. longulus *Sm.* ♀, skg. (Herm. Müller, 'Weit. Beob.,' III, pp. 78–9).

1742. P. orbiculare L. (Kirchner, op. cit., Jahreshefte Ver. Natk., Stuttgart, liii, 1897, p. 223.)—Kirchner states that the heads contain from 15 to 30 flowers, and that though insect-visits are very numerous, the stylar branches roll back into spirals of 1½ turns, so as to render automatic self-pollination possible.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Loew (Switzerland), a bee (Halictus sp.), a butterfly (Polyommatus virgaureae *L.*), a Noctuid (Agrotis ocellina *S.-V.*), and 2 hawk-moths (Ino geryon *Hb.*, var. chrysocephala *Nick.*, and Zygaena exulans *Hchhw. et Rein.*). MacLeod (Pyrenees), 4 humble-bees, a fossorial wasp, and a Muscid.

1743. P. hemisphaericum L.—Kirchner says that in this species the head contains 8–16 flowers, or sometimes a smaller number. Kerner states that automatic self-pollination is rendered possible by the rolling back of the stylar branches.

Visitors.—Herm. Müller (Alps), a fly, 9 bees, and 21 Lepidoptera ('Alpenblumen,' pp. 409–10). von Dalla Torre (Tyrol), the humble-bee Bombus mastrucatus *Gerst.*

1744. P. humile Schleich.—Kerner says that in this species autogamy takes place in the usual way.

Visitors.—Herm. Müller saw 6 Lepidoptera in Switzerland ('Alpenblumen,' p. 410).

1745. P. pauciflorum L. (Kirchner, Jahreshefte Ver. Natk., Stuttgart, liii, 1897, p. 224.)—Kirchner states that the heads of this species contain 5–6 (more rarely 8) small flowers. He also remarks that the three (sometimes four) stylar branches but rarely roll back at the end of anthesis sufficiently far to bring their tips into contact with the pollen on the style. It appears therefore that in spite of the small size of the flowers and the unfavourable habitat in which they grow, automatic self-pollination but rarely takes place.

Visitors.—Ricca observed humble-bees even at a height of 2900 m. (Atti Soc. ital. sc. nat., Milano. xiii, 1870).

1746. P. Scheuchzeri All.—Kirchner says that the heads of this species contain 15–30 flowers. Autogamy takes place, according to Kerner, in the same way as in P. hemisphaericum.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Switzerland), 3 Hymenoptera (including 2 humble-bees) and a Lepidopterid ('Alpenblumen,' p. 411). Friese (Tyrol), 2 Alpine bees—Dufourea alpina *Mor.*, freq.; and Halictoides paradoxus *Mor.*, rare (also recorded by Morawitz, and Schletterer and von Dalla Torre). von Dalla Torre (Alps), the bee Bombus alpinus *F.*, up to a height of 2500 m.

1747. P. Halleri All.—The heads of this species contain 40 flowers on an average. Autogamy may take place as in P. Michelii.

Visitors.—Herm. Müller observed 5 flies, 3 bees, and 4 Lepidoptera in the Alps ('Alpenblumen,' p. 413).

1748. P. comosum L. (Kirchner, Jahreshefte Ver. Natk., liii, 1897, pp. 224–5.)—This species belongs to the sub-genus Synotoma *G. Don*, characterized by umbellate inflorescences and the permanent union of the tips of the corolla-lobes. Kirchner investigated the flower mechanism in the South Tyrol, and describes it as follows.—

The corolla remains a closed tube throughout anthesis until the flowers wither. They are odourless, borne on pedicels 2 mm. long, and 8–20 of them are arranged in a hemispherical head-like umbel. The number, however, may vary from 3 to 25. The inferior ovary is 5 mm. long and the subulate epigynous calyx-teeth are 4 mm. in length. The corolla is 16 mm. long, ventricose, and 5 mm. broad below, tapering above, and ending in a cylindrical tube 8 mm. in length. The last part is produced into five small teeth, and is of a dark-violet colour, while the lower portion of the corolla is bright-blue. The dark-violet style projects for 16 mm. from the opening of the corolla, which it almost completely fills. It divides at the end into two (sometimes three) branches 5 mm. long, and it is covered with pollen for its entire length. At the beginning of anthesis the stylar branches are apposed; they then curve outwards, and finally roll up into spirals of $1\frac{1}{2}$ turns, so as to render automatic self-pollination possible. The five stamens possess bluish-white filaments 6 mm. long, and dark anthers of the same length which dehisce introrsely before the expansion of the corolla and deposit their pollen on the hairs covering the style. This elongates and makes the pollen available to insects, and the stylar branches diverge afterwards. After dehiscence the anthers maintain their erect position within the corolla. Nectar is secreted in the base of the flower by a dark-violet ring surrounding the base of the bluish-white style. It can only be reached from the mouth of the corolla by a very long and thin proboscis, such as that of butterflies, which Kirchner feels sure are the pollinating agents, though he did not succeed in observing their visits.

Kirchner adduces the fact that two species such as P. comosum and P. canescens belong to the same genus, although they differ so markedly in form and mechanism, as a particularly striking example of the danger of concluding that two species are pollinated in the same way merely because they are closely related.

517. Jasione L.

Flowers social and protandrous. Their mechanism agrees essentially with that of Phyteuma, but approaches more nearly that of Compositae in the fact that the investment of the pollen-covered style is made up of the basally united anthers and not of the cohering corolla-lobes. Beyer states that the smaller insects only dust the sides of their bodies with pollen. Larger ones simultaneously touch and pollinate several of the small crowded flowers.

1749. J. montana L. (Sprengel, 'Entd. Geh.,' pp. 115–18; Herm. Müller, 'Fertilisation,' pp. 369–73, 'Weit. Beob.,' III, p. 79; Verhoeff, 'Bl. u. Insekt. a. d.

Ins. Norderney'; de Vries, Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875; MacLeod, 'Pyreneënbl.,' p. 371; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 99, 100, 163, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 237, 'Blütenbiol. Beob. a. d. Ins. Rügen'; Kirchner, 'Flora v. Stuttgart,' p. 649, Jahreshefte Ver. Natk., liii, 1897, pp. 226–7.)—Sprengel long ago described the flower mechanism of this species in a careful and accurate manner. A head contains 100–200 blue flowers, the corollas of which are divided almost to their bases into five narrow linear lobes, so that the nectar secreted on the top of the ovary is accessible to insects of the most various kind. In the second stage of anthesis the stylar hairs and the pollen attached to them have disappeared, while the style projecting beyond the corolla-lobes unfolds its bifid stigma. Automatic self-pollination is therefore excluded.

FIG. 214. *Jasione montana*, *L.* (after Herm. Müller). (1) Reproductive organs of a young bud: the undehisced anthers have been pressed apart to show the stylar brush which they surround. (2) Ditto of an older bud: the anthers have shed their pollen on the stylar brush, and contracted into narrow lobes which cohere at their bases into a ring surrounding the style. (3) Flower in the first (male) stage. (4) Ditto in the second (female) stage, after removal of the calyx and corolla. *a*, undehisced anthers; *a'*, dehisced ditto; *f*, sweeping-hairs; *fi*, filaments; *gr*, style; *ov*, ovary; *p*, corolla; *po*, pollen; *s*, calyx; *st*, stigma.

VISITORS.—Knuth observed the following in Schleswig-Holstein (S.-H.) and Rügen (R.).—

A. Coleoptera. *Cerambycidae*: 1. Strangalia melanura *L.*, po-dvg. (R.). **B. Diptera.** (*a*) *Muscidae*: 2. Aricia incana *Wied.* (S.-H.); 3. Nemoraea consobrina *Mg.* (S.-H.); 4. Onesia sepulcralis *L.* (S.-H.); 5. Scatophaga stercoraria *L.* (S.-H.); 6. Spilogaster carbonella *Zett.* (S.-H.); 7. S. communis *R.-D.* (S.-H.). (*b*) *Syrphidae*: 8. Eristalis arbustorum *L.* (S.-H.); 9. E. sp. (S.-H.); 10. E. tenax *L.* (S.-H.); 11. Helophilus pendulus *L.* (S.-H.); 12. Syritta pipiens *L.* (S.-H.); 13. Syrphus sp. (S.-H.); 14. Volucella bombylans *L.*, var. plumata *Mg.* (S.-H. and R.). All skg. **C. Hymenoptera.** *Apidae*: 15. Apis mellifica *L.* (S.-H.); 16. Bombus terrester *L.* (S.-H.); 17. Halictus malachurus *K.* ♀ (R.). All skg. and po-cltg. **D. Lepidoptera.** (*a*) *Rhopalocera*: 18. Argynnis paphia *L.* (R.); 19. Epinephele janira *L.* (S.-H. and R.); 20. Lycaena semiargus *L.* (S.-H.); 21. Pararge maera *L.* (S.-H.); 22. Polyommatus phlaeas *L.* (S.-H.); 23. Vanessa urticae *L.* (S.-H.). (*b*) *Sphingidae*: 24. Zygaena filipendula *L.* (S.-H.); 25. Z. sp. (R.). All skg.

Alfken observed the following.—

In Bremen.—**A. Diptera.** *Syrphidae*: 1. Chrysotoxum festivum *L.* **B. Hymenoptera.** (*a*) *Apidae*: 2. Anthidium strigatum *Ltr.* ♂; 3. Andrena denticulata

K. ♀ and ♂; 4. A. flavipes *Pz.*, 2nd gen.; 5. A. gwynana *K.* ♀, do.; 6. A. marginata *F.* ♀; 7. A. nigriceps *K.* ♀ and ♂; 8. A. propinqua *Schenck* ♀; 9. A. shawella *K.* ♀ and ♂; 10. A. tarsata *Nyl.* ♀ and ♂; 11. A. tibialis *K.* ♀ and ♂, 2nd gen.; 12. Bombus agrorum *F.* ♂; 13. B. hortorum *L.* ☿, skg.; 14. B. lapidarius *L.* ☿; 15. B. lucorum *L.* ☿; 16. B. proteus *Gerst.* ☿; 17. Coelioxys acuminata *Nyl.* ♀ and ♂, skg.; 18. C. mandibularis *Nyl.* ♀, skg.; 19. Colletes marginatus *L.* ♀; 20. Dasypoda argentata *Pz.* ♀; 21. D. plumipes *Pz.* ♀ and ♂, only skg.; 22. Dufourea halictula *Nyl.* ♀; 23. D. vulgaris *Schenck* ♀ and ♂; 24. Epeolus variegatus *L.* ♀ and ♂; 25. Eriades campanularum *K.* ♀; 26. E. nigricornis *Nyl.* ♀; 27. Halictoides inermis *Nyl.* ♀ and ♂; 28. Halictus calceatus *Scop.* ♀ and ♂; 29. H. flavipes *F.* ♀; 30. H. leucozonius *Schr.* ♀; 31. H. levis *K.* ♂; 32. H. punctulatus *K.* ♀ and ♂; 33. H. rubicundus *Chr.* ♀ and ♂; 34. H. tumulorum *L.* ♀; 35. H. zonulus *Sm.* ♀; 36. Megachile centuncularis *L.* ♂; 37. Nomada brevicornis *Mocs.* ♂; 38. N. flavoguttata *K.* ♀, 2nd gen.; 39. N. fuscicornis *Nyl.* ♀; 40. N. jacobaeae *Pz.* ♀ and ♂; 41. N. obtusifrons *Nyl.* ♀ and ♂; 42. N. similis *Mor.* ♀ and ♂; 43. N. solidaginis *Pz.* ♀ and ♂, skg.; 44. N. roberjeotiana *Pz.* ♀ and ♂; 45. Podalirius bimaculatus *Pz.* ♀ and ♂; 46. P. furcatus *Pz.* ♀; 47. P. vulpinus *Pz.* ♀; 48. Prosopis communis *Nyl.* ♀ and ♂; 49. P. confusa *Nyl.* ♀ and ♂; 50. P. genalis *Ths.* ♀ and ♂; 51. P. pictipes *Nyl.* ♀ and ♂; 52. Psithyrus quadricolor *Lep.* ♂. (*b*) *Sphegidae*: 53. Ammophila campestris *Ltr.* ♂; 54. Crabro subterraneus *F.* ♀ and ♂. In Juist.—**A. Diptera.** *Syrphidae*: 1. Eristalis tenax *L.*, very common. **B. Hymenoptera.** *Apidae*: 2. Bombus lapidarius *L.* ☿ and ♂, very common, skg.; 3. B. muscorum *F.* **C. Lepidoptera.** (*a*) *Lycaenidae*: 4. Polyommatus phlaeas *L.* (*b*) *Satyridae*: 5. Satyrus semele *L.* (*c*) *Noctuidae*: 6. Plusia gamma *L.*

Verhoeff records the following for Norderney.—

A. Diptera. (*a*) *Muscidae*: 1. Echinomyia tessellata *F.* ♀; 2. Lucilia latifrons *Schin.* ♀ and ♂, very common. (*b*) *Syrphidae*: 3. Helophilus trivittatus *F.* ♀; 4. Melithreptus scriptus *L.* ♀; 5. M. strigatus *Staeg.* ♂; 6. Platycheirus sp.; 7. Syrphus corollae *F.* ♂, freq.; 8. Syritta pipiens *L.* ♂. **B. Hymenoptera.** (*a*) *Apidae*: 9. Bombus lapidarius *L.* ☿ and ♂, very common; 10. Coelioxys sp.; 11. Prosopis communis *Nyl.* ♀. (*b*) *Sphegidae*: 12. Ammophila lutaria *F.* (=A. affinis *K.*) ♀, skg. (*Cf.* Verhoeff, Nova Acta Leop., Halle, lxi, 1894, p. 160.) **C. Lepidoptera.** (*a*) *Nymphalidae*: 13. Argynnis latonia *L.* (*b*) *Satyridae*: 14. Pararge megaera *L.*, one.

Loew noticed the following in Silesia ('Beiträge,' p. 32).—

A. Coleoptera. *Cerambycidae*: 1. Leptura maculicornis *Deg.*, nect-lkg. **B. Diptera.** *Conopidae*: 2. Physocephala nigra *Deg.* ♀, skg. **C. Lepidoptera.** *Rhopalocera*: 3. Polyommatus hipponoë *Esp.*, skg.; also (op. cit., p. 25),—**A. Coleoptera.** 1. Cryptocephalus sericeus *L.*, nect-lkg. **B. Hymenoptera.** (*a*) *Apidae*: 2. Megachile argentata *F.* ♂, skg.; 3. Saropoda rotundata *Panz.* ♀, skg. and po-cltg. (*b*) *Sphegidae*: 4. Ammophila sabulosa *L.*, skg.; 5. Bembex rostrata *L.*, ♀ and ♂, skg.

Burkill and Willis record the following for Central Wales ('Fls. and Insects in Gt. Britain,' Part I).—

A. Coleoptera. *Nitidulidae*: 1. Meligethes viridescens *F.*, po-dvg. **B. Diptera.** (*a*) *Muscidae*: 2. Anthomyia radicum *L.*, freq., po-dvg.; 3. A. sp., do.; 4. Lucilia cornicina *F.*; 5. Oscinis sp.; 6. Scatophaga stercoraria *L.*, skg. (*b*) *Syrphidae*: 7. Eristalis tenax *L.*, skg.; 8. Helophilus pendulus *L.*; 9. Melanostoma scalare *F.*, skg.; 10. Platycheirus manicatus *Mg.* **C. Hymenoptera.** (*a*) *Apidae*: 11. Bombus agrorum *F.*, skg.; 12. B. terrester *L.*, do. (*b*) *Formicidae*: 13. Formica fusca *L.*, skg. **D. Lepidoptera.** *Rhopalocera*: 14. Pieri rapae *L.*; 15. Polyommatus phlaeas *L.*

Herm. Müller (H. M.) for Westphalia (W.), Thuringia (T.), and the Bavarian Oberpfalz (O.), and Buddeberg (Budd.) for Nassau, give the following list.—

A. Coleoptera. (*a*) *Cerambycidae*: 1. Leptura livida *L.*, in large numbers, nect-lkg. (H. M.); 2. Strangalia melanura *L.*, freq., skg. (H. M., T.). (*b*) *Chrysomelidae*: 3. Cryptocephalus sericeus *L.* (H. M.). (*c*) *Oedemeridae*: 4. Oedemera virescens *L.* (H. M.). **B. Diptera.** (*a*) *Bombyliidae*: 5. Exoprosopa capucina *F.*, not infrequent, skg. (H. M.). (*b*) *Conopidae*: 6. Myopa fasciata *Mg.*, skg. (H. M.); 7. Physocephala rufipes *F.*, numerous, skg. (H. M.); 8. P. vittata *F.*, skg. (H. M.); 9. Sicus ferrugineus *L.*, do. (H. M.); 10. Zodion notatum *Mg.*, do. (H. M.). (*c*) *Empidae*: 11. Empis livida *L.*, very common, skg. (H. M.). (*d*) *Muscidae*: 12. Anthomyia sp., po-dvg. (H. M.); 13. Echinomyia ferox *Pz.*, skg. (H. M.); 14. E. tessellata *F.*, very common, skg. (H. M.); 15. Ocyptera brassicaria *F.*, do. (H. M.); 16. O. cylindrica *F.*, do. (H. M.); 17. Oliviera lateralis *Pz.*, do. (H. M.). (*e*) *Syrphidae*: 18. Eristalis aeneus *Scop.*, skg. (H. M.); 19. E. arbustorum *L.*, do. (H. M.); 20. E. tenax *L.*, do. (H. M.); 21. Eumerus sabulonum *Fall.*, do. (H. M.); 22. Helophilus pendulus *L.*, do. (H. M.); 23. Melanostoma mellina *L.*, do. (H. M.); 24. Melithreptus dispar *Lw.*, po-dvg. (H. M.); 25. M. menthastri *L.*, skg. (H. M.); 26. M. scriptus *L.*, do. (H. M.); 27. Paragus tibialis *Fall.*, po-dvg. (H. M.); 28. Pipizella sp. (H. M.); 29. Rhingia rostrata *L.*, skg. (H. M.); 30. Syritta pipiens *L.*, do. (H. M.); 31. Syrphus pyrastri *L.*, do. (H. M.); 32. S. ribesii *Mg.*, do. (Budd.); 33. Volucella bombylans *L.*, skg. (H. M.); these Syrphids partly po-dvg. (*f*) *Tabanidae*: 34. Tabanus rusticus *F.*, skg. (H. M., O.). **C. Hymenoptera.** (*a*) *Apidae*: 35. Andrena argentata *Sm.* ♂ (H. M.); 36. A. coitana *K.* ♂ and ♀ (H. M.); 37. A. dorsata *K.* ♀ and ♂, freq.; 38. A. fulvago *Chr.* ♀ (H. M.); 39. A. fulvicrus *K.* ♀ (H. M.); 40. A. hattorfiana *F.* ♂, once (H. M.); 41. A. helvola *L.* ♀ (H. M.); 42. A. pilipes *F.* ♂ (H. M.); 43. A. fulvescens *K.* ♂, skg. (H. M.); 44. Anthidium strigatum *Ltr.* ♂ (H. M.); 45. Bombus hortorum *L.* ♀ and ☿, skg. (H. M.); 46. B. sylvarum *L.* ☿, do. (H. M.); 47. Ceratina cucurbitina *Rossi F.* ♂, do. (Budd.); 48. C. cyanea *K.* ♀ and ♂, in large numbers, skg. and po-cltg. (H. M.); 49. Chelostoma campanularum *K.* ♀ (H. M.); 50. Cilissa leporina *Pz.* ♀ (H. M.); 51. Coelioxys conoidea *Ill.* (=C. punctata *Lep.*) ♀ (H. M.); 52. C. quadridentata *L.* ♀ and ♂, skg. (H. M.); 53. C. simplex *Nyl.* ♀ and ♂, do. (H. M.); 54. Colletes marginatus *L.* ♂ (H. M.); 55. Dasypoda hirtipes *F.* ♂, in large numbers (H. M.); 56. Diphysis serratulae *Pz.* ♀ (H. M.); 57. Epeolus variegatus *L.* ♀ and ♂, in large numbers (H. M.); 58. Halictus albipes *F.* ♀ (H. M.); 59. H. cylindricus *F* ♀ and ♂ (H. M.); 60. H. fasciatus *Nyl.* ♀ (H. M.); 61. H. flavipes *F.* ♂ (H. M.); 62. H. leucozonius *Schr.* ♀ (H. M.); 63. H. lucidulus *Schenck* ♀ (H. M.); 64. H. maculatus *Sm.* ♀, skg. (Budd.); 65. H. malachurus *K.* ♀, do. (Budd.); 66. H. villosulus *K.* ♀ (H. M.); 67. Megachile argentata *F.* ♂ and ♀, freq., po-cltg. and skg. (H. M.); 68. M. maritima *K.* ♂ (H. M.); 69. Nomada fabriciana *L.* (H. M.); 70. N. fuscicornis *Nyl.* ♀, skg. (H. M.); 71. N. jacobaeae *Pz.* (H. M.); 72. N. lineola *Pz.* ♂ (H. M.); 73. N. nigrita *Schenck* ♂ (H. M.); 74. N. roberjeotiana *Pz.* ♀ and ♂ (H. M.); 75. N. ruficornis *L.* ♀ and ♂ (H. M.); 76. N. rhenana *Mor.*, skg. (H. M.); 77. N. varia *Pz.* ♀ and ♂ (H. M.); 78. Prosopis communis *Nyl.* ♀ and ♂, freq. (H. M.); 79. P. dilatata *K.* ♂ (H. M.); 80. P. hyalinata *Sm.* ♀, freq. (H. M.); 81. P. pictipes *Nyl.* ♀, rare (H. M.); 82. P. variegata *F.* ♀ and ♂, very common (H. M., O. and W.); 83. Psithyrus rupestris *L.* ♀, skg. (H. M.); 84. Rhophites halictula *Nyl.* ♀, skg. (H. M.); 85. Saropoda bimaculata *Pz.* ♀ and ♂, very numerous, skg. and po-cltg. (H. M.); 86. Sphecodes gibbus *L.* ♀ (=S. rufescens *Fourcr.*), skg. and po-cltg. (H. M.); 87. Stelis aterrima *Pz.* ♂ (H. M.). (*b*) *Chrysididae*: 88. Hedychrum lucidulum *F.*, skg. (H. M.). (*c*) *Evaniidae*: 89. Foenus sp., skg. (H. M.). (*d*) *Sphegidae*: all skg.: 90. Ammophila sabulosa *L.* ♂, in large numbers (H. M.); 91. Cerceris arenaria *L.*, ♀ and ♂, freq. (H. M.); 92. C. labiata *F.* ♀, skg. (H. M., O. and W.); 93. C. nasuta *Kl.* ♂, skg. (H. M.); 94. Ceropales maculatus *F.*,

in large numbers (H. M.); 95. Crabro alatus *Pz.* ♀ and ♂, very common (H. M.); 96. C. patellatus *Pz.* ♀, not infrequent (H. M.); 97. C. pterotus *Pz.* ♀ and ♂, do. (H. M.); 98. C. vexillatus *Pz.* ♀ (Budd.); 99. Lindenius albilabris *F.* (H. M.); 100. Mellinus sabulosus *F.*, in large numbers (H. M.); 101. Miscus campestris *Ltr.* ♀ (H. M.); 102. Oxybelus bellicosus *Ol.* (H. M.); 103. O. mandibularis *Dahlb.* (H. M.); 104. O. uniglumis *L.*, freq. (H. M.); 105. Philanthus triangulum *F.* (H. M.); 106. Pompilus rufipes *L.* ♂ (H. M.); 107. P. viaticus *L.* ♂ (H. M.); 108. Psammophila affinis *K.* ♂ and ♀, very numerous (H. M.); 109. Tachytes pectinipes *L.* (H. M.). **D. Lepidoptera.** (*a*) *Rhopalocera*: all skg.: 110. Coenonympha pamphilus *L.* (H. M.); 111. Epinephele janira *L.*, freq. (H. M.); 112. Hesperia thaumas *Hfn.* (H. M.); 113. Lycaena aegon *W. V.* ♂ (H. M.); 114. Pieris napi *L.* (H. M.); 115. Polyommatus dorilis *Hfn.*, repeatedly (H. M.); 116. P. phlaeas *L.*, freq. (H. M.). (*b*) *Sphingidae*: 117. Ino statices *L.*, skg. (H. M.); 118. Zygaena lonicerae *Esp.*, do. (H. M.).

Herm. Müller adds the following remarks to his list ('Fertilisation,' p. 373).—'*Jasione montana* stands in the front rank of our native plants in regard to the number and variety of its insect-visitors; it is only matched by some Umbelliferae and Compositae, which share with it the advantages of fully-exposed honey, and the union of numerous flowers with freely-projecting reproductive stigmas and anthers in a conspicuous inflorescence. In all such plants cross-fertilization is completely ensured, and accordingly the possibility of self-fertilization has been lost.'

The following were recorded by the observers, and for the localities stated.—

Friese (Mecklenburg), the primitive bee Prosopis dilatata *K.*, occasional; (Baden), the parasitic bee Nomada obtusifrons *Nyl.* ♂. Sickmann (Osnabrück), 3 Sphegids—1. Crabro subterraneus *F.*, fairly freq.; 2. Oxybelus bipunctatus *Oliv.*, occasional; 3. Salius minutus *v. d. L.* Gerstäcker (Berlin), the leaf-cutting bee Megachile argentata *F.*, together with its parasite the small bee Coelioxys brevis *Ev.* (=C. erythropyga *Foerst.*). Schmiedeknecht (Thuringia), the parasitic bee Nomada similis *Mor.* ♀. Krieger (Leipzig), the fossorial wasp Cerceris labiata *F.* Schenck (Nassau), the delicate bee Halictus (Nomioides) pulchellus *Schenck.* Kohl (Tyrol), the fossorial wasp Crabro peltarius *Schr.* ♀ and ♂. MacLeod (Flanders), Apis, 3 hover-flies, and a Muscid (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 374); and also 2 humble-bees, 8 other Hymenoptera, 8 hover-flies, 4 other Diptera, a beetle, and 7 Lepidoptera (op. cit., v, 1893, pp. 438–9); (Pyrenees), a species of Halictus, a Lepidopterid, a beetle, and a hover-fly (op. cit., iii, 1891, p. 370). H. de Vries (Netherlands), 2 humble-bees—Bombus pratorum *L.* ♂, and B. terrester *L.* ☿ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875). E. D. Marquard (Cornwall), 2 bees—Andrena nigriceps *K.*, and Nomada obtusifrons *Nyl.* Willis (neighbourhood of the south coast of Scotland), the butterfly Pieris napi *L.*, skg. ('Fls. and Insects in Gt. Britain,' Part I). Scott-Elliot (Dumfriesshire), a humble-bee, a short-tongued bee, 2 Muscids, and 3 hover-flies ('Flora of Dumfriesshire,' p. 109).

1750. J. perennis Lam. (Kirchner, Jahreshefte Ver. Natk., Stuttgart, p. 227; MacLeod, 'Pyreneënbl.,' p. 370.) Kirchner investigated this species in the Hohenheim Botanic Garden, and describes its mechanism as very similar to that of J. montana, though the bright-blue heads are much larger, being about 30 mm. in diameter. When the flower opens, the end of the style, laden with the reddish pollen, projects as a club-shaped swelling, much as in J. montana. The style itself may be of the same length as the erect corolla-lobes, or rather shorter. The latter diverge somewhat irregularly from one another, so that the shrivelled whitish anthers can be seen in the base of the flower. The blue style, at first about 6 mm. long,

elongates to some 12 mm., and when all the pollen adhering to it has been removed the whitish stigma expands. Automatic self-pollination is therefore excluded.

Visitors.—Kirchner observed butterflies (Vanessa urticae *L.*, and Epinephele janira *L.*). MacLeod (Pyrenees) noticed a bee, a Lepidopterid, 2 flies, and a beetle.

LIX. ORDER *VACCINIACEAE* LINDL.

518. Vaccinium L.

Feebly protandrous bee flowers, or flowers with concealed nectar, which Sprengel says is secreted by a swelling on the ovary. There are appendages to the anthers, projecting laterally or vertically, and when insect visitors strike against these the pollen is shaken out.

Hermann Müller ('Fertilisation,' p. 373) was at first inclined to doubt Sprengel's view as to the position of the nectary, for he did not find the swelling on the ovary moist with nectar. He suggested that the swollen bases of the filaments were secretory in function. The latter view was adopted by Kerner ('Nat. Hist. Pl.,' Eng. Ed. 1, II). Later on, however, Hermann Müller admitted the correctness of Sprengel's statement ('Alpenblumen,' p. 381), and Ricca has convinced himself that the swelling at the base of the style really does secrete nectar (Atti Soc. ital. sc. nat., Milano, xiv, 1871).

Kerner says that in the species of Vaccinium automatic self-pollination is ultimately possible, for the flowers, though erect at first, become pendulous, so that pollen can fall on the stigma.

Fig. 215. *Vaccinium*, *L.* (after Herm. Müller). (1) Flower of V. Myrtillus *L.*, slightly enlarged and seen from the side. (2) Do. of V. uliginosum *L.*, seen from the side after removal of half the corolla (× 7).

1751. V. Myrtillus L. (Sprengel, 'Entd. Geh.,' p. 230; Herm. Müller, 'Fertilisation,' pp. 373–5, 'Alpenblumen,' p. 381; Lindmann, 'Bidrag till Känned. om Fjellväxt. Blomn. o. Befrukt.'; MacLeod, Bot. Jaarb. Dodonaea, Ghent, ii, 1891, p. 374, v, 1893, pp. 447–8; Loew, 'Blütenbiol. Floristik,' p. 395; Knuth, 'Bloemenbiol. Bijdragen.')—This species bears feebly protandrous bee flowers. These are bright-green in colour, with a reddish tinge, and odourless; but in spite of their inconspicuousness they are very rich in nectar. Sprengel says that this is secreted by a white annular swelling on the ovary, surrounding the base of the style.

The pendulous corolla is strongly ventricose, and its mouth is so contracted that only bees with a proboscis sufficiently long to reach the base of the flower are able to act as pollinating agents. The capitate stigma projects a little from the opening of the flower, and the head of an insect visitor therefore touches it before the anthers, which are hidden within the bell. The latter lie above the stigma and surround the style. They dehisce apically, and each of them possesses two long

diverging processes stretching as far as the corolla. When the proboscis of a bee is inserted into the bell it strikes against one of these processes, causing the dry powdery pollen to fall out of the opening of the corolla on to the visitor's head. Should insect-visits fail, the pollen ultimately falls of its own accord on the edge of the stigma, effecting automatic self-pollination.

Visitors.—Herm. Müller saw the following bees in Westphalia.—

1. Andrena nigroaenea *K.* ♂ (proboscis 3½ mm. long), vainly trying to suck; 2. Apis mellifica *L.* ☿, very freq., skg.; 3. Bombus agrorum *F.* ♀, freq., skg., persistently visiting and holding on to the under-sides of the bells; 4. B. lapidarius *L.* ♀, do., but not so freq.; 5. B. scrimshiranus *K.* ♀, do.; 6. B. terrester *L.* ♀, do.

Alfken and Höppner (H.) observed the following at Bremen.—

A. Diptera. (*a*) *Asilidae*: 1. Laphria flava *L.* ♂, skg. (H.). (*b*) *Conopidae*: 2. Conops vesicularis *L.* ♀ and ♂, freq., skg. (H.); 3. Physocephala nigra *Deg.* ♂, skg. (H.); 4. P. rufipes *F.* (*c*) *Syrphidae*: 5. Eristalis alpinus *Pz.* ♀, skg. (H.). (*d*) *Muscidae*: 6. Sarcophaga carnaria *L.* **B. Hymenoptera.** *Apidae*: 7. Andrena albicans *Müll.* ♀ (H.); 8. A. convexiuscula *K.* ♂; 9. A. gwynana *K.* ♀; 10. A. lapponica *Zett.* ♀ skg. and po-cltg. ♂ skg.; 11. A. nigroaenea *K.* (H.); 12. A. parvula *K.* ♀; 13. A. varians *K.* ♀ and ♂; 14. Apis mellifica *L.* ☿; 15. Bombus agrorum *F.* ♀ and ♂; 16. B. derhamellus *K.* ♀ and ♂; 17. B. hortorum *L.* ♀; 18. B. jonellus *K.* ☿ very common, skg. and po-cltg. ♂; 19. B. lapidarius *L.* ♀ and ☿; 20. B. muscorum *F.* ♀; 21. B. pratorum *L.* ♀ and ☿, skg.; 22. B. proteus *Gerst.* ♀; 23. B. terrester *L.* ♀ and ☿, skg. and po-cltg.; 24. Halictus calceatus *Scop.* ♀; 25. H. flavipes *F.* ♀ (H.); 26. Nomada bifida *Ths.* ♀; 27. N. borealis *Zett.* ♀ (H.), skg.; 28. N. lineola *Pz.* (H.), skg.; 29. N. ruficornis *L.* (=N. flava *Pz.* ♀); 30. N. succincta *Pz.* ♀ (H.), skg.; 31. Osmia rufa *L.*; 32. O. uncinata *Gerst.* ♂, skg.; 33. Psithyrus campestris *Pz.* ♀, skg.; 34. P. vestalis *Fourcr.* ♀, skg.

The following were recorded by the observers, and for the localities stated.—

Knuth (Sachsenwalde), the honey-bee, and 3 humble-bees—1. Bombus agrorum *F.* ♀; 2. B. lapidarius *L.* ♀; 3. B. terrester *L.* ♀, freq., skg. Loew (Silesia) ('Beiträge,' p. 54), 3 bees—1. Bombus latreillellus *K.* ♂, skg.; 2. B. pratorum *L.* ☿, skg.; 3. B. variabilis *Schmiedekn.* ☿, skg. Schmiedeknecht (Thuringia), 4 bees—1. Andrena lapponica *Zett.*; 2. Bombus jonellus *K.* ♀; 3. B. mastrucatus *Gerst.* ♀; 4. Osmia corticalis *Gerst.* Rössler (Wiesbaden), the Geometrid moth Halia brunneata *Thunbg.* Friese in Alsace (A.), Baden (B.), and Thuringia (T.), 4 bees—1. Andrena lapponica *Zett.* not infreq. (B.); 2. Bombus mastrucatus *Gerst.* ☿ occasional (B.), ♀ do. (A.); 3. Osmia corticalis *Gerst.* (T.); 4. O. vulpecula *Gerst.* (T.). Frey-Gessner (Switzerland), the bee Osmia nigriventris *Zett.* (=O. corticalis *Gerst.*). Schletterer and von Dalla Torre (Tyrol), and Hoffer (Steiermark), the humble-bee Bombus mastrucatus *Gerst.* Morawitz (St. Petersburg), the bee Andrena fucata *Sm.* McLeod (Flanders), the humble-bee Bombus agrorum *F.* ♀ (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 448); (Pyrenees), 3 humble-bees (op. cit., iii, 1891, p. 374). Willis and Burkill (Central Wales), 2 humble-bees—Bombus agrorum *F.*, freq., skg., and B. terrester *L.*, do. ('Fls. and Insects in Gt. Britain,' Part I). Scott-Elliot (Dumfriesshire), 2 humble-bees ('Flora of Dumfriesshire,' p. 110). Schneider (Arctic Norway), 3 humble-bees—1. Bombus lapponicus *F.*; 2. B. pratorum *L.*; 3. B. scrimshiranus *K.* (Tromsø Mus. Aarsh., 1894). Lindmann (Dovrefjeld), a humble-bee.

1752. V. uliginosum L. (Herm. Müller, 'Fertilisation,' pp. 373–5, 'Weit. Beob.,' III, p. 67, 'Alpenblumen,' p. 381; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 100, 113; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 107, 526; Loew, 'Blütenbiol. Floristik,' p. 399.)—Hermann Müller says that the flower mechanism of this species agrees with that of the last, except as regards the following points.—

The flowers are borne on taller bushes, are more numerous, and coloured red on the side next the sun, so that they are much more conspicuous than those of V. Myrtillus. As the opening of the flower is 3 mm. broad, small insects can push their heads and the front part of their bodies into the corolla. The stigma does not project from the flower as in V. myrtillus, but is situated a little way inside the corolla, so that the smaller bees (sp. of Andrena, Halictus, and Nomada) are obliged to touch it before their heads are dusted with pollen. (*Cf.* Fig. 215.)

V. Myrtillus, therefore, is adapted to the visits of a select number of the more industrious long-tongued bees, and V. uliginosum to those of a much larger set of insects, some with a long and others with a short proboscis. This has been confirmed by direct observation, as Hermann Müller emphasizes.

Warming describes the flowers of the Arctic variety *microphyllum* Lange (Fig. 216) as first feebly protandrous and then homogamous: they are rather smaller than in the type form (Bot. Tids., Kjöbenhavn, 1895, pp. 47–9). Both cross- and self-pollination are possible, and it is probable that the latter may even take place pseudo-cleistogamously in the bud. Numerous fruits are set, even when insect-visits fail.

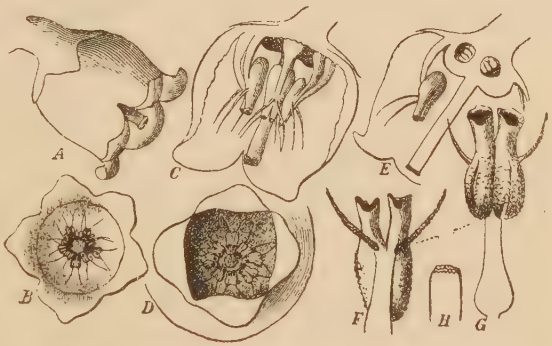


FIG. 216. *Vaccinium uliginosum*, *L.*, var. *microphyllum*, *Lange* (after E. Warming). *A*. Flower seen from the side. *B*. Do. from below. *C*. Do. with part of corolla removed. *D*. Do. from below. *E*. Do. in longitudinal section. *F* and *G*. Stamens. *H*. End of style with stigma. (*A–E* ×4½; *F*, *G*, *H* ×12.)

Lindman says that the flowers of plants growing on the Dovrefjeld possess a strong aromatic odour, resembling that of pepper. The corolla varies in length from 5 to 7 mm. Although the anthers develop rather before the stigma, their pollen is not ripe until the latter has become receptive. The stigma and nectary are larger in the small flowers than in those of greater size.

Ekstam says that the flowers are feebly protandrous, indeed almost homogamous, in the Swedish Highlands.

In Greenland this variety is a low small-leaved shrub in habit, often with its branches running close to the ground, and with flowers usually only 3 mm. (rarely 6 mm.) long. Wormskjold says that it smells like woodruff, but Warming and Vanhöffen were unable to confirm this. The latter botanist collected ripe fruits on Storö as early as the beginning of July (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' pp. 59–62).

VISITORS.—Verhoeff observed the following in Norderney.—

A. Diptera. *Muscidae*: 1. Lucilia caesar *L.*, a ♀, skg. **B. Hymenoptera.** (*a*) *Apidae*: 2. Bombus hortorum *L.*, a ♀, skg.; 3. B. lapidarius *L.*, 2 ♀, skg.; 4. B. proteus *Gerst.*, a ♀, skg.; 5. B. terrester *L.*, a ♀, skg.; 6. Psithyrus rupestris *F.*, a ♀, skg.; 7. P. vestalis *Fourcr.* ♀, freq., skg. (*b*) *Formicidae*: 8. Formica fusca *L.* (=Rasse fusca *Forel*) ☿, skg.

Herm. Müller saw 3 humble-bees in the Alps, and gives the following list for Westphalia.—

A. Diptera. (*a*) *Empidae*: 1. Empis opaca *F.*, skg., extraordinarily numerous. (*b*) *Muscidae*: 2. Echinomyia fera *L.*, repeatedly, skg. (*c*) *Syrphidae*: 3. Eristalis arbustorum *L.*, in very great numbers, skg.; 4. E. horticola *Deg.*, one, skg.; 5. E. intricarius *L.*, do.; 6. Rhingia rostrata *L.*, freq., skg. **B. Hymenoptera.** *Apidae*: 7. Andrena atriceps *K.* ♂, skg.; 8. A. fulva *Schr.* ♀, skg.; 9. A. gwynana *K.* ♀, skg.; 10. A. nigroaenea *K.* ♀ and ♂, skg.; 11. A. pilipes *F.* ♂, skg.; 12. Apis mellifica *L.* ☿, freq., skg.; 13. Bombus agrorum *F.* ♀, skg.; 14. B. confusus *Schenck* ♀, skg.; 15. B. hortorum *L.* ☿, skg.; 16. B. sylvarum *L.* ♀, skg.; 17. B. pratorum *L.* ♀, skg.; 18. B. terrester *L.* ♀, in large numbers, skg.; 19. Colletes cunicularius *L.* ♀, skg.; 20. Halictus cylindricus *F.* ♀, skg.; 21. H. flavipes *F.* ♀, skg.; 22. H. rubicundus *Chr.* ♀, skg.; 23. H. sexnotatus *K.* ♀, skg.; 24. H. sexstrigatus *Schenck* ♀, skg.; 25. H. zonulus *Sm.* ♀, one, skg.; 26. Nomada ferruginata *K.* ♀, skg.; 27. N. ruficornis *L.* ♀, skg.; 28. N. sexcincta *K.* ♂, skg.; 29. N. succincta *Pz.* ♀, one, skg.; 30. Osmia rufa *L.* ♀, skg.; 31. Psithyrus campestris *Pz.* ♀, skg.; 32. P. vestalis *Fourcr.* ♀, do. **C. Lepidoptera.** *Rhopalocera*: 33. Lycaena argiolus *L.*, skg.; 34. Thecla rubi *L.*, do.

The following were recorded by the observers, and for the localities stated.—

Knuth (North Frisian Islands), Apis, a humble-bee, and a hover-fly. Loew (on the Albula, in the Alps), 2 humble-bees (Bombus alpinus *L.* ♀, and B. alticola *Krchb.* ☿) and a hover-fly (Sericomyia lappona *L.*). Frey (canton Graubünden), the Tortricid moth Phoxopteryx myrtillana *Tr.* Schneider (Arctic Norway), 3 humble-bees—1. Bombus lapponicus *F.*; 2. B. pratorum *L.*; 3. B. scrimshiranus *K.* (Tromsø Mus. Aarsh., 1894). Lindman (Dovrefjeld), a humble-bee.

1753. V. Vitis-Idaea L. (Herm. Müller, 'Alpenblumen,' pp. 380–1; Warming, 'Bestövningsmaade,' p. 7; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Ricca, Atti Soc. ital. sc. nat., Milano, xiv, 3, 1871.)—This species is homogamous. The flowers are white in colour, often with a reddish tinge, widely open, and oblique. Nectar is secreted as in the last species, and the passage to it is covered by the stamens, of which the filaments are clothed with hairs externally and laterally. The anthers closely surround the style, are produced into tubes, and dehisce apically, allowing some pollen to escape when insect visitors strike against them. The stigma matures at the same time as the anthers, and are first touched by visitors, which then press the latter apart and get dusted with pollen. Crossing is therefore ensured by insect-visits.

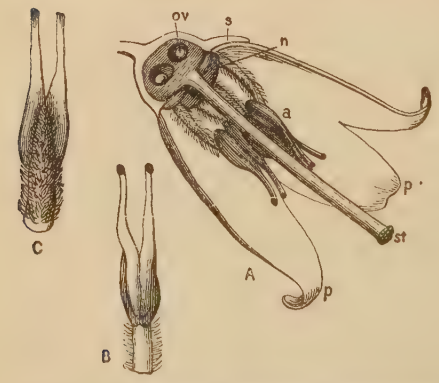


FIG. 217. *Vaccinium Vitis-Idaea*, *L.* (after Herm. Müller). *A.* Flower in longitudinal section (× 5). *B.* Stamen seen from the inner side (× 7). *C.* Do. from the outer side. *a*, anther; *n*, nectary; *ov*, ovary; *p*, corolla; *s*, calyx: *st*, stigma.

Warnstorf describes the flowers as protogynous, with a style which may be only as long as the stamens, equal in length to the corolla, or exserted. The flowers are not infrequently male by suppression of the pistil. The white filaments are covered with hairs externally as well as marginally, and such of these hairs as are situated in the base of the flower serve as nectar-covers. The pollen-grains are white in colour,

irregularly tetrahedral or of indeterminate shape, tuberculate, up to 44 μ in diameter.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Usedom, where the plant covers large tracts), Apis and 3 humble-bees (1. Bombus hortorum *L.* ♀; 2. B. lapidarius *L.* ☿; 3. B. terrester *L.* ☿), all freq., skg. A. Röse (Thuringia), two humble-bees—Bombus hortorum *L.*, and B. terrester *L.* Alfken (Bremen), 4 humble-bees—1. Bombus jonellus *K.* ♀; 2. B. muscorum *F.* ♀; 3. B. proteus *Gerst.* ♀; 4. B. terrester *L.* ♀. Friese (Thuringia), the bee Osmia nigriventris *Zett.* Herm. Müller (Alps), Apis and 3 humble-bees. Scott-Elliot (Dumfriesshire), an Empid and a Muscid ('Flora of Dumfriesshire,' p. 111).

The arctic variety *pumilum* Hornem. (Greenland, Labrador) has been investigated by Warming, who describes it as follows (Bot. Tids., Kjöbenhavn, 1895, pp. 44–6).—

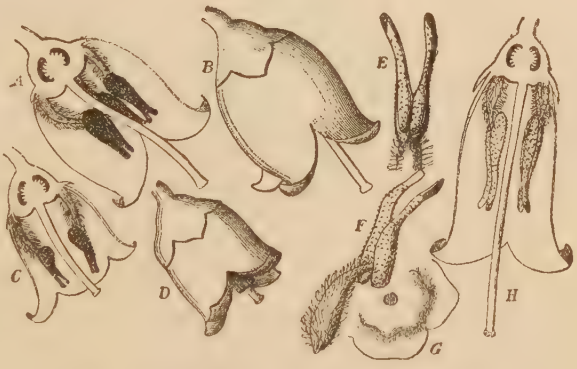


Fig. 218. *Vaccinium Vitis-Idaea*, *L.* (after E. Warming). *A–G.* Var. *pumilum*, from Greenland. *A*, *B*. Larger flowers. *C*, *D*. Smaller flowers. *E*, *F*. A stamen from *A*. *G*. Nectary. *H*. Type-form, from Stockholm. (*A–D*, *H* × 4.)

The flowers vary in size, sometimes being only half as large as those of the type form, though relatively broader. In these small flowers the style only reaches to the mouth of the corolla, where the anthers are situated, so that self-pollination can easily take place. But in the larger ones the style projects from the corolla, as in the type form (Fig. 218). Fruits are only set in warm years.

Ekstam describes the flowers as feebly protandrous, odourless, and 4–8 mm. in diameter.

1754. V. Oxycoccos L. (=Oxycoccos palustris *Pers.*). (Sprengel, 'Entd. Geh.,' pp. 228–9; Herm. Müller, 'Weit. Beob.,' III, pp. 67–9; Warming, 'Bestövningsmaade'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 107; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—Although Kerner gives an admirable account of the flower mechanism of this species, he failed to observe that the visits of bees inevitably effect crossing. The red wheel-shaped corolla is reflexed, and Sprengel says that the anthesis of individual flowers lasts for eighteen days.

As in other species, the nectar is sheltered from rain by the pendulous position of the flower, and Kerner says it is protected against unbidden guests by the stamens, which closely surround the style. Hermann Müller points out that the stamens are also the means by which bees of suitable size are forced to effect crossing. They are so greatly broadened as to form a tube round the style, their outer surface is rough with short hairs, and their closely apposed edges are beset with longer curly hairs, so closely interwoven that a nectar-seeking insect is unable to succeed in penetrating between them. The anthers are borne on the inner sides of the filaments, and each

of them is produced into a pair of tubes as long as itself, open at the tip, and closely embracing the style. In order to get at the nectar, bees must climb on to the flowers from below, and thrust their proboscis between the tubular prolongation of the anthers, from which pollen falls upon their heads. Since the stigma is the part projecting furthest from the corolla, it is first touched by the pollen-covered heads of bee visitors, so that crossing must necessarily take place. Lindman says that automatic self-pollination is not assured in the var. *pusilla* Rupr., owing to the great distance between stigma and anthers, but Warming is of opinion that in Greenland it may take place in the bud, for very numerous fruits are set there. Warnstorf describes the pollen-grains as white in colour, and up to 50 μ in diameter.

Visitors.—In spite of long and careful watching I have never been able to observe any, nor was Herm. Müller more successful. The latter adds that though honey-bees quench their thirst with the water which permeates the masses of Sphagnum in the immediate neighbourhood of the flowers, they do not trouble about these. He also correlates the very long time for which anthesis lasts with the sparsity of insect-visits. Scott-Elliot observed 2 Muscids, which were obviously useless guests ('Flora of Dumfriesshire,' p. 111).

LX. ORDER *ERICACEAE* LINDL.

(including Rhodoraceae *Klotsch*, and Pyrolaceae *Lindl.*).

Literature.—Knuth, 'Grundriss d. Blütenbiol.,' p. 70; Drude, in Engler u. Prantl., 'D. nat. Pflanzenfam.,' IV, 1, p. 25.

Flowers usually in racemes, rarely (Andromeda) in umbels: nectar concealed in the base of the corolla. The anthers generally possess two processes which reach the corolla, are struck by insect visitors, and serve as levers for scattering the pollen, which consists in many species of loosely connected tetrads.

1. Tribe Arbuteae.

519. Arctostaphylos Adans.

Homogamous or feebly protogynous humble-bee flowers, with nectar secreted by a fleshy ring surrounding the ovary. Kerner states that automatic self-pollination can ultimately take place as in Vaccinium.

1755. A. Uva-ursi Spreng. (=A. officinalis *Wimm. et Grab.*, and Arbutus Uva-ursi *L.*). (Herm. Müller, 'Alpenblumen,' pp. 385–8.)—The pendulous flowers of this species are arranged in short terminal racemes, and the corollas are almost conical bells. The nectar does not remain adhering to the nectary, but is sheltered in ten pits which surround it at the base of the corolla. It is prevented from running away by the dense hairy covering of the filaments and inner surface of the corolla. It is also protected against unbidden guests by long erect hairs at the opening of the corolla. The ten filaments are narrow at their bases, and then enlarge very quickly to form a ring surrounding the ovary, afterwards narrowing again, but continuing to remain apposed to the ovary for some distance. Their ends project beyond

the ovary, running parallel to the style, and each of them bears two inwardly directed anther-lobes, which open by pores below, and are produced into tail-like appendages extending to the corolla.

Only the most skilful insects, humble-bees and bees, are able to get at the nectar quickly and easily, by hanging on to the flower from below and probing for it through the small opening of the corolla. In doing this the proboscis is almost certain to touch, and if previously dusted with pollen to pollinate the stigma, which lies a little distance within the opening of the corolla and is covered with a thick sticky fluid. It next strikes against one or more of the 20 tail-like anther-appendages, causing some of the smooth pollen-grains (loosely aggregated into tetrads) to fall upon it. Crossing is thus ensured by insect-visits.

Kerner states that the flowers are very feebly protogynous. Towards the end of anthesis, should insect-visits fail, pollen falls upon the stigma, which is at a lower level than the anthers, so that automatic self-pollination is possible as a last resort.

In plants observed by Lindman on the Dovrefjeld the flowers were strongly fragrant. The appendages of the anthers are much shorter in this locality than in the Alps, but the edge of the stigma is produced into a rim, so that automatic self-pollination can more easily be effected. Warming states ('Arkt. Växt. Biol.,' pp. 18–21) that autogamy is also easily possible in Greenland, and is effective. In that country the flowers are homogamous, while the anthers dehisce and the stigma becomes receptive in the bud.

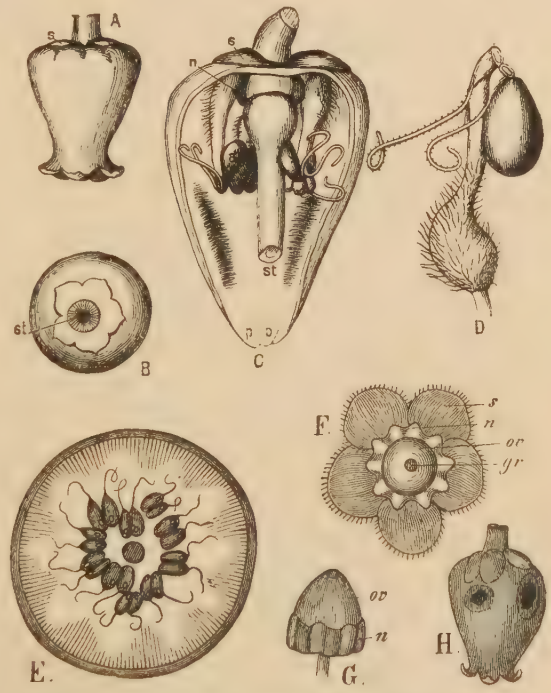


FIG. 219. *Arctostaphylos Uva-ursi*, *Spreng.* (after Herm. Müller). *A*. Flower seen from the side (× 3). *B*. Do. from below. *C*. Sketch of interior of bud shortly before opening (× 7). *D*. Stamen (× 15). *E*. Flower cut through transversely under the anthers, seen from below (× 7). *F*. Calyx, ovary, and nectary, seen from below (× 7). *G*. Ovary and nectary turned up, and seen from the side (× 7). *H*. A flower perforated by Bombus mastrucatus. *a*, anthers; *gr*, style; *n*, nectary; *ov*, ovary; *p*, petals; *s*, sepals; *st*, stigma.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 3 humble-bees skg. legitimately and one perforating the flowers, a Lepidopterid (as an unbidden guest), and Thrips (do.). Lindman, 2 humble-bees. MacLeod (Pyrenees), a humble-bee (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 374). Höppner (Bremen), the humble-bee Bombus agrorum *F.* ♀, skg.

1756. A. alpina Spreng. (=Arbutus alpina *L.*). (Warming, 'Arkt. Växt. Biol.,' pp. 13–18.)—This species has so far been investigated in northern habitats, but not in alpine ones. The pendulous ovoid flowers are 5–6 mm. long, and arranged in short terminal racemes. Warming says that in Greenland they are either homogamous or feebly protogynous. In that country the plant blossoms very early in the neighbourhood of snow- and ice-fields, and sets fruit abundantly. There is a strong autogamous tendency, for the pollen falls very easily on the large sticky stigma which lies below the anthers, and this is found to be dusted with it soon after the flower opens. The fall of pollen is checked, however, by the narrow opening of the corolla and the hairs which line it. The appendages of the anthers are less well developed than in A. Uva-ursi, and in specimens from Greenland may be entirely absent. (*Cf.* Fig. 220.)

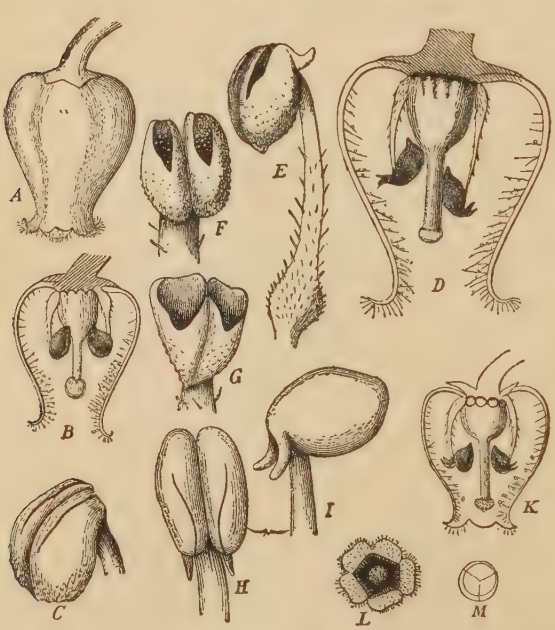


FIG. 220. *Arctostaphylos alpina, Spreng.* (after E. Warming). *A, B.* External view and longitudinal section of a flower; though only just opened, the pollen has fallen from the anthers (× 4). *C.* An anther from the same flower; there are no appendages. *D.* Longitudinal section through a flower with a tolerably short style (× 8). *E, F, G.* Anthers and filaments in various positions and of different ages (× 20). *H, I.* Anthers from a bud (× 20). *K.* Longitudinal section through a flower with a long style. *L.* Limb and opening of a corolla, from below; the stigma can be seen within the latter (limb about 2½ mm. and aperture 1 mm. in diameter). *M.* Tetrad of pollen-grains.

520. Arbutus L.

1757. A. Unedo L. (Sprengel, 'Entd. Geh.,' pp. 240–1.)—

VISITORS. — Schletterer observed at Pola — 1. The beautiful humble-bee Bombus argillaceus *Scop.*, on fine days in November and December; 2. Bombus terrester *L.*, freq., in September, October, and November.—

'On sunny days when there was no wind it was also occasionally seen in January. I noticed it frequently during the Christmas season up to the end of January on the late blossoms of the strawberry-tree.'

1758. A. Andrachne L. (Entleutner, Öst. bot. Zs., Wien, xxxix, 1889.)—

VISITORS.—In some of the flowers of this species at Meran, Entleutner noticed small Muscids held fast by the tangled hairs, suffering the penalty of death for their greediness. He also mentions that some insects had 'bitten through the flower-urn close to the calyx.'

2. Tribe Andromedeae.

521. Andromeda L.

Flowers usually homogamous, with concealed nectar secreted at the base of the ovary.

1759. A. Polifolia L. (Loew, 'Blütenbiol. Floristik,' p. 270; Warming, 'Arkt. Växt. Biol.,' pp. 19–21.)—In this species five or more delicate pendent flowers are arranged in an almost umbellate inflorescence at the end of the stem. The bright-red peduncles are about three times as long as the flowers, which are 5 mm. in length and of about the same breadth. The bell-shaped corolla-tube is red in colour, while the teeth are white with five reddish longitudinal streaks. Loew describes the bell as possessing a pentagonal opening about 1½ mm. broad, formed entirely by the short reflexed corolla-lobes. The inside of the corolla is clothed with hairs, and the filaments are also hairy. In this way the nectar secreted by ten swellings at the base of the ovary is protected, and pollen is prevented from falling out of the flower.

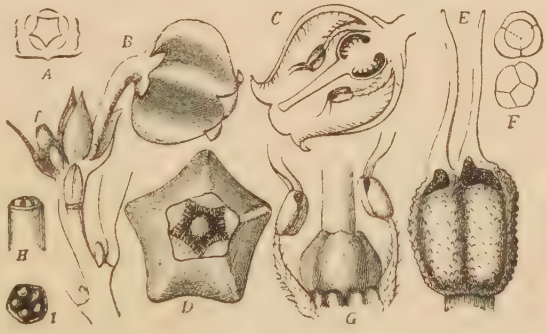


Fig. 221. *Andromeda Polifolia*, *L.* (after E. Warming). *A.* Diagram of a flower with its bract and bracteoles. *B.* The end of a flowering branch; below are two foliage-leaves with small leaf-buds in their axils; above these a third foliage-leaf has been removed to show the further developed leaf-bud in its axil. Above this again are two bracts respectively subtending a flower-bud (*f*) and a fully developed flower; between these are closely apposed bracteoles (× 3). *C.* Longitudinal section through a mature flower. *D.* A flower seen from above (× 4). *E.* An anther (× 20). *F.* Pollen. *G.* Ovary with nectary and 2 stamens (× 8). *H*, *I.* End of the style, and stigma.

The stigma is receptive when the flower opens, is situated in the opening of the corolla, and projects beyond the dark-brown anthers, which Loew says mature simultaneously in the March of Brandenburg. In normal flowers the anther-pores are directed inwards, and the appendages outwards. The nectar can be reached by a proboscis of 3–4½ mm. long. Warming states that in the arctic plants he examined automatic self-pollination could be effected, should insect-visits fail, by fall of pollen on to the stigma, which completely fills the narrow opening of the corolla. Lindman, whose observations were made on the Dovrefjeld, says that the stigma becomes receptive in the bud, and he sometimes found pollen-grains on its edge, which is beset with five small rounded projections. In other cases he noticed pollen on the under-side of the stigma, suggesting insect-visits.

Visitors.—Alfken (Bremen) noticed 2 humble-bees (Bombus lapidarius *L.* ♀, very freq., skg., and B. muscorum *F.* ♀, freq., skg., persistently visiting this species, but avoiding other nectar-yielding plants, e.g. Ajuga, growing close by) and a butterfly (Thecla rubi *L.*, very freq., skg.).

522. Cassiope D. Don.

Bell-shaped pendulous flowers, with nectar secreted by yellow nectaries at the base of the ovary.

1760. C. tetragona D. Don. (Warming, Bot. Tids., Kjöbenhavn, xv, 1885, pp. 25–9.)—Warming thinks this arctic species possibly belongs to flower class **Lm.** The yellowish-white flowers exhale an odour of hawthorn, especially towards evening. The pollen is scattered by the impact of the proboscis of insect visitors against the diverging appendages of the anthers. Crossing by insects is possible, but in Greenland automatic self-pollination generally takes place while the flowers are closed.

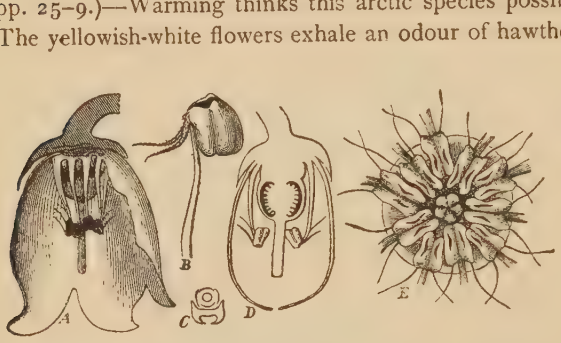


FIG. 222. *Cassiope tetragona*, *D. Don* (after E. Warming). *A*. Diagram of a flower seen from the side (× 4). *B*. A stamen. *C*. Diagrammatic plan of the same. *D*. Longitudinal section of a flower (× 4). *E*. Stamens and stigma seen from below (× 10).

The species is abundant on heaths in Spitzbergen, and Ekstam says that its pendulous flowers erect themselves when anthesis is over ('Blütenbiol. Beob. a. Spitzbergen,' p. 9). It blossoms in that island from the end of June to the middle of September, and sets abundant fruits (Andersson and Hesselman, 'Bidrag till Känned. om Spetsbergens o. Beeren Eil. Kärlväxtflora,' p. 18). Vanhöffen was unable to perceive the odour of hawthorn described by Warming (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' p. 49).

VISITORS.—Ekstam observed numerous small insects in Spitzbergen.

1761. C. hypnoides D. Don (=Andromeda hypnoides *L.*). (Warming, op. cit. pp. 29–31.)—Warming describes the flowers of this species as white with purple-red corolla-lobes. They are more widely open than those of the last species, and Lindman says that they possess a tolerably strong odour. Warming found the species to be homogamous in Greenland, but on the Dovrefjeld Lindman observed that the flowers were at first protogynous, afterwards becoming homogamous. Autogamy resulting in the setting of numerous fruits apparently takes place before the flowers open, by fall of pollen upon the clearly defined stigma, which is covered with a sticky resinous fluid. (*Cf.* Fig. 223.)

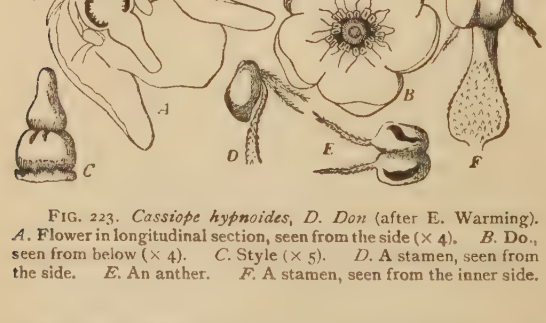


FIG. 223. *Cassiope hypnoides*, *D. Don* (after E. Warming). *A*. Flower in longitudinal section, seen from the side (× 4). *B*. Do., seen from below (× 4). *C*. Style (× 5). *D*. A stamen, seen from the side. *E*. An anther. *F*. A stamen, seen from the inner side.

Vanhöffen compares the species to a Polytrichum in habit, and he found it in Greenland with numerous (? last year's) fruits, collected together under the delica

white flowers, the corolla-lobes of which are of a purple-red colour (op. cit., p. 49). Nathorst found it in full bloom in Spitzbergen (1. 8. '68) (Andersson and Hesselman, op. cit., p. 12).

3. Tribe Ericeae.

523. **Calluna** Salisb.

Feebly protandrous, pinkish-red, rarely white flowers, aggregated into racemes; with concealed nectar, secreted in the base of the flower by eight little swellings alternating with the filaments.

1762. C. vulgaris Salisb. (=Erica vulgaris *L.*). (Sprengel, 'Entd. Geh.,' p. 230; Herm. Müller, 'Fertilisation,' pp. 377–80, 'Alpenblumen,' p. 382, 'Weit. Beob.,' III, p. 67; Lindman, 'Bidrag till Känned. om Skandin. Fjellväxt. Blomn. o. Befrukt.'; Verhoeff, 'Bl. u. Insekt. a. d. Ins. Norderney'; de Vries, Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875; MacLeod, Bot. Jaarb. Dodonaea, Ghent, iii, 1891, v, 1893; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 101, 163, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 227, 238; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 139; Loew, 'Blütenbiol. Floristik,' p. 390; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The attraction of insects effecting cross-pollination is brought about by the enlarged red, rarely white calyx, the aggregation of the flowers into dense unilateral racemes, and last, but not least, by the association together of vast numbers of plants.

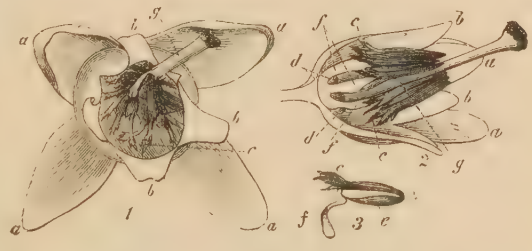


Fig. 224. *Calluna vulgaris*, *Salisb.* (after Herm. Müller). (1) Older flower, seen almost directly from below. (2) Younger do., after removal of half the calyx and corolla, seen from the side. (3) A stamen. *a*, sepals; *b*, petals; *c*, appendages of the anthers; *d*, nectary; *e*, openings of the anthers; *f*, filaments; *g*, style.

Hermann Müller describes the flowers as feebly protandrous, with small bells 2–3 mm. in length. The stamens and pistil are so bent up in the almost horizontal blossoms that the nectar is conveniently accessible from below. The larger insects (bees and humble-bees) hang on to the flowers, pulling them down by their weight, and suck from below; the smaller ones, on the contrary, push their head or proboscis into the flowers from the front in order to secure nectar, and in doing so get dusted with pollen from above.

The anthers dehisce in the bud, and their rough appendages, beset with stiff erect hairs, so block the outer part of the flower that a proboscis probing for nectar is obliged to strike against them, when pollen is showered down. The four-lobed stigma projects considerably beyond the tips of the anthers, and does not usually become receptive until all the pollen is shed, though some of this may previously adhere to it. Crossing is therefore ensured by insect-visits, and automatic self-pollination is excluded.

Kerner states that the flowers are only at first adapted to insect-pollination, becoming anemophilous later on. The secretion of nectar then ceases, the filaments

elongate, so that the anthers become exserted, and the pollen is carried by the wind to the stigmas of younger flowers. (*Cf.* Vol. I, p. 71.) Warnstorf describes the pollen-masses as containing 3 or 4 grains of whitish colour, irregular, beset with rows of tubercles, and 37–44 μ in diameter.

Visitors.—Knuth observed the following in Schleswig-Holstein.—

A. Diptera. All skg. or po-dvg.: *Syrphidae*: 1. Eristalis tenax *L.*; 2. Syritta pipiens *L.*; 3. Syrphus balteatus *Deg.*; 4. S. sp. **B. Hymenoptera.** *Apidae*: all skg. 5. Apis mellifica *L.*; 6. Bombus cognatus *Steph.* ☿; 7. B. terrester *L.* ☿; 8. Psithyrus rupestris *F.* ♂. **C. Lepidoptera.** All skg. (*a*) *Noctuidae*: 9. Plusia gamma *L.* (*b*) *Rhopalocera*: 10. Coenonympha pamphilus *L.*; 11. Polyommatus phlaeas *L.*

Herm. Müller gives the following list.—

A. Diptera. (*a*) *Muscidae*: 1. Sarcophaga carnaria *L.*, skg. (*b*) *Syrphidae*: 2. Cheilosia longula *Zett.*; 3. C. scutellata *Fall.*, skg.; 4. Chrysotoxum octomaculatum *Curt.*, do.; 5. Melithreptus scriptus *L.*, do.; 6. Sericomyia borealis *Fall.*, do. (Thuringia); 7. Syritta pipiens *L.*, do.; 8. Syrphus sps., do. **B. Hymenoptera.** (*a*) *Apidae*: 9. Andrena dorsata *K.* ♀, skg. and po-cltg.; 10. A. fulvicrus *K.* ♀, skg.; 11. A. fuscipes *K.* ♀ and ♂, do.; 12. A. lapidarius *L.* ☿, do.; 13. A. parvula *K.* ♀, skg. and po-cltg.; 14. A. simillima *Sm.* ♀ and ♂, do.; 15. Apis mellifica *L.* ☿, extremely numerous, skg.; 16. Bombus terrester *L.* ♀, ☿ and ♂, skg. (also in the Alps); 17. Diphysis serratulae *Pz.* ♀, skg.; 18. Halictus cylindricus *F.* ♂, do.; 19. Saropoda bimaculata *Pz.* ♀, do., with heather-pollen among its collecting-hairs; 20. Sphecodes gibbus *L.* ♀, skg. (*b*) *Vespidae*: 21. Vespa holsatica *F.* ☿, skg. **C. Lepidoptera.** *Rhopalocera*: 22. Vesperia thaumas *Hfn.* (=V. linea *W. V.*), skg. **D. Thysanoptera.** 23. Thrips, freq.

Alfken and Höppner (H.) observed the following at Bremen.—

A. Diptera. (*a*) *Bombyliidae*: 1. Systoechus sulphureus *Mik.* (*b*) *Muscidae*: 2. Echinomyia grossa *L.*; 3. E. tessellata *F.* (*c*) *Syrphidae*: 4. Arctophila mussitans *F.*; 5. Chrysotoxum festivum *L.*; 6. Syrphus pyrastri *L.*; 7. Volucella bombylans *L.* **B. Hymenoptera.** (*a*) *Apidae*: 8. Andrena argentata *Sm.* ♀; 9. A. fuscipes *K.* ♀ and ♂; 10. A. nigriceps *K.* ♀ and ♂; 11. A. thoracica *F.* ♀, skg., 2nd gen.; 12. Apis mellifica *L.*, very common; 13. Bombus agrorum *F.* ♂, ♀ and ☿; 14. B. arenicola *Ths.* ☿ and ♂ (H.); 15. B. confusus *Schenck* ♂; 16. B. derhamellus *K.* ♂; 17. B. distinguendus *Mor.* ♀, skg. (H.); 18. B. hortorum *L.* (=B. nigricans *Schmiedekn.*) small ☿, skg.; 19. B. jonellus *K.* ♂, in great numbers, up to end of September, skg., ♀ and ☿; 20. B. lapidarius *L.* ☿ and ♂; 21. B. lucorum *L.* ☿; 22. B. muscorum *F.* ♀, ☿ and ♂; 23. B. proteus *Gerst.* ♂; 24. B. terrester *L.* ♂; 25. B. variabilis *Schmiedekn.* ♀, ☿ and ♂ (H.); 26. Colletes succinctus *L.* ♀ skg. and po-cltg., ♂ skg.; 27. Dufourea vulgaris *Schenck* ♀ skg. and po-cltg., ♂ skg.; 28. Halictoides inermis *Nyl.* ♂; 29. Halictus calceatus *Scop.* ♀ and ♂; 30. H. leucozonius *Schr.* ♂; 31. H. punctulatus *K.* ♂; 32. H. rubicundus *Chr.* ♂; 33. H. sexnotatulus *Nyl.* ♂; 34. Nomada brevicornis *Mocs.* ♂, skg.; 35. N. jacobaeae *Pz.* ♀, skg.; 36. N. obtusifrons *Nyl.* ♀, skg.; 37. N. roberjeotiana *Pz.* ♀, skg.; 38. N. solidaginis *Pz.* ♀ and ♂, skg.; 39. Prosopis pictipes *Nyl.* ♂; 40. Psithyrus campestris *Pz.* ♀ and ♂ (H.); 41. P. rupestris *F.* ♂. (*b*) *Sphegidae*: 42. Cerceris arenaria *L.* ♀ and ♂ skg.; 43. Mellinus arvensis *L.* ♀ and ♂, do. (*c*) *Tenthredinidae*: 44. Athalia lugens *Ths.*; 45. A. rosae *L.*

Willis and Burkill record the following for Central Wales ('Fls. and Insects in Gt. Britain,' Part I).—

A. Diptera. (*a*) *Muscidae*: 1. Calliphora erythrocephala *Mg.*; 2. Onesia cognata *Mg.*; 3. O. sepulcralis *Mg.*; 4. Lucilia cornicina *F.*, freq.; 5. Pollenia rudis *F.* (*b*) *Syrphidae*: 6. Eristalis tenax *L.*, freq., skg.; 7. Melanostoma scalare

F., skg.; 8. Platycheirus manicatus *Mg.*; 9. Sericomyia borealis *Flor.* **B. Hymenoptera.** (*a*) *Apidae*: 10. Bombus agrorum *F.*, skg.; 11. B. hortorum *L.*, do.; 12. B. lapidarius *L.*, do.; 13. B. lapponicus *F.*, do.; 14. B. scrimshiranus *K.*, do.; 15. B. terrester *L.*, freq., skg. (*b*) *Formicidae*: 16. Formica fusca *L.*, skg. (*c*) *Vespidae*: 17. Vespa vulgaris *L.*, skg. **C. Lepidoptera.** All skg.: (*a*) *Rhopalocera*: 18. Coenonympha pamphilus *L.*; 19. Lycaena icarus *Rott.*; 20. Polyommatus phlaeas *L.*; 21. Vanessa urticae *L.* (*b*) *Microlepidoptera*: 22. Undetermined species.

Willis saw the following in the neighbourhood of the south coast of Scotland ('Fls. and Insects in Gt. Britain,' Part I).—

A. Diptera. (*a*) *Muscidae*: 1. Anthomyia radicum *L.*, skg.; 2. A. sp., po-dvg.; 3. Limnophora sp., do.; 4. Scatophaga stercoraria *L.*, freq., po-dvg.; 5. Themira minor *Hal.*, freq., skg. (*b*) *Syrphidae*: 6. Platycheirus albimanus *F.*, freq., skg. and po-dvg.; 7. P. manicatus *Mg.*, freq., skg.; 8. Sericomyia borealis *Flor.*, freq., po-dvg. **B. Hymenoptera.** *Apidae*: 9. Apis mellifica *L.*, very common, skg.; 10. Bombus agrorum *F.*, freq., skg.; 11. B. pratorum *L.*, skg.; 12. B. scrimshiranus *K.*, do.; 13. B. terrester *L.*, freq., skg. **C. Lepidoptera.** (*a*) *Rhopalocera*: 14. Polyommatus phlaeas *L.*, skg. (*b*) *Tortricidae*: 15. Teras aspersana *Hub.*, skg.

The following were recorded by the observers, and for the localities stated.—

Sickmann (Osnabrück), the fossorial wasp Mellinus arvensis *L.* (Hollingsholthausen), the fossorial wasp M. sabulosus *L.* Verhoeff (Norderney).—**A. Diptera.** (*a*) *Bibionidae*: 1. Dilophus vulgaris *Mg.*, freq. (*b*) *Muscidae*: 2. Calliphora erythrocephala *Mg.*, freq.; 3. Lucilia latifrons *Schin.*, do. **B. Hymenoptera.** *Apidae*: 4. Bombus lapidarius *L.* ♀, ☿ and ♀, freq., skg.; 5. B. terrester *L.* ☿, not infrequent, skg.; 6. Psithyrus rupestris *F.* ♂, skg. Loew (Brandenburg), the humble-bee Bombus agrorum *F.* ☿, skg. ('Beiträge,' p. 41). Krieger (Leipzig), 7 bees—1. Andrena fuscipes *K.* ♀ and ♂; 2. Bombus hypnorum *L.* ☿; 3. B. soroënsis *F.* ☿ and ♂; 4. B. terrester *L.* ☿ and ♂; 5. B. variabilis *Schmiedekn.* ♂; 6. Nomada solidaginis *Pz.*; 7. Psithyrus vestalis *Fourcr.* ♀ and ♂. Schmiedeknecht (Thuringia), 4 bees—1. Andrena argentata *Sm.*; 2. A. pubescens *K.* (=A. fuscipes *K.*); 3. Bombus terrester *L.* ♂; 4. Nomada solidaginis *Pz.* Rössler (Wiesbaden), the moth Agrotis castanea *Esp.*, and remarks, 'This moth confirms the often quoted axiom that Lepidoptera appear to pay attention to their food-plant mostly at the time when it comes into bloom.' Friese, in Baden (B.), Hungary (H.), Fiume (F.), and Mecklenburg (M.), 4 bees—1. Andrena fuscipes *K.* (B., not infreq.; M., freq.); 2. Colletes succinctus *L.* (F. and M., freq.; H., occasional); 3. Epeolus variegatus *L.* (B. and M., occasional); 4. Nomada jacobaeae *Pz.* (B., one ♀), Schiner (Austria), the Muscid Siphona geniculata *Mg.* Frey (Switzerland), 4 moths—1. Grapholitha mendiculana *Tr.*; 2. Pholopteryx unguicella *L.*; 3. Gelechia ericetella *Hb.*; 4. Plemota bicostella *Cl.* Schletterer and von Dalla Torre (Tyrol), 7 bees—1. Bombus alticola *Krchb.*; 2. B. confusus *Schenck*; 3. B. mastrucatus *Gerst.*; 4. B. sylvarum *L.*; 5. B. variabilis *Schmiedekn.*; 6. Colletes succinctus *L.*; 7. Sphecodes ephippius *L.* Ducke (Austrian Silesia), the bee Andrena simillima *Sm.* Hoffer (Steiermark), the bee Andrena argentata *Sm.*, po-cltg. Gerstäcker (Upper Bavaria), the alpine humble-bee Bombus alticola *Krchb.* ♂ and ☿. MacLeod (Flanders), Apis, 3 humble-bees, 3 other Hymenoptera, 9 hover-flies, 5 other flies, and 7 Lepidoptera (Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 449–50); (Pyrenees), only a hover-fly (Syritta sp.) (op. cit., iii, 1891, p. 373). H. de Vries (Netherlands), 3 bees—1. Apis mellifica *L.* ☿; 2. Bombus subterraneus *L.* ☿; 3. B. terrester *L.*, ♂ and ☿ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875). Lindman (Dovrefjeld), a humble-bee. Morawitz (St. Petersburg), 2 bees—1. Andrena argentata *Sm.*; 2. A. nigriceps *K.* Smith (England), the bee Colletes succinctus *L.* Scott-Elliot (Dumfriesshire), Apis, 4 humble-bees, several flies and Lepidoptera ('Flora of Dumfriesshire,' p. 112).

524. Erica L.

The species of this genus belong to flower classes **H, L, LH, C,** and **An.**

1763. E. Tetralix L. (Herm. Müller, 'Fertilisation,' pp. 376–7, 'Weit. Beob.,' III, p. 67; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 450–1; Schulz, 'Beiträge'; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 161, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' 238.)—This species belongs to the class of bee flowers. The pendulous red flower bells, aggregated into capitulo-umbellate inflorescences, make the plant very conspicuous. Hermann Müller says that their mechanism agrees with those of Vaccinium Myrtillus and V. uliginosum. The flower bell is 7 mm. long, and its central part 4 mm. broad. The ovary is sessile in the bottom of the flower, and its base is surrounded by a blackish annular nectary, the secretion of which accumulates where it is formed. The blackish sticky stigma occupies the narrow (only 2 mm.) opening of the corolla, or even projects from it, so that an insect visitor hanging on to the blossom and probing for nectar must first touch this, effecting cross-pollination if another flower has previously been visited. At the same time the insect's proboscis is moistened with the sticky stigmatic fluid, and made ready to receive a fresh supply of pollen. The downwardly directed anther-pores are situated somewhat above the stigma, and the pairs of long pointed thorn-like anther-processes stretch as far as the wall of the bell. Immediately after the proboscis of a nectar-seeking insect has touched the stigma, it strikes against some of these processes, and some of the dry powdery pollen falls from the anther-pores upon the front part of its head, adhering to the part previously made sticky with stigmatic fluid. When the next flower is visited crossing must take place, the head of the insect being at the same time sprinkled with more pollen. Failing insect-visits, automatic self-pollination is effected by fall of pollen on the edge of the stigma. I have not myself determined whether the flowers become anemophilous towards the end of anthesis.

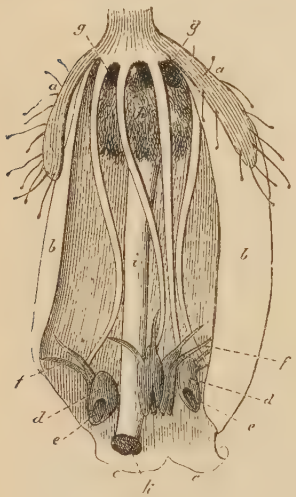


FIG. 225. *Erica Tetralix*, L. (after Herm. Müller). A flower from which the front half of the corolla has been removed. *a*, calyx; *b*, corolla; *c*, reflexed limb of the same; *d*, stamens (partly displaced); *e*, the downwardly directed openings of the anthers; *f*, appendages of the anthers, which are struck against by the proboscis of insects probing the flower; *g*, nectary; *h*, ovary; *i*, style; *k*, stigma.

A proboscis 7 mm. long is required to obtain the nectar, and as that of the honey-bee is only 6 mm. in length, this zealous visitor is unable to suck legitimately. It therefore perforates the bell somewhere about the middle, and steals the nectar through the aperture. Hermann Müller, however, observed it sucking autumn flowers in the normal fashion, and he thinks that these are perhaps a little smaller than those developed in the warmer part of the year, so that the proboscis of the honey-bee may be long enough to get at the nectar legitimately (*cf.* my remark below).

Visitors.—Herm. Müller gives the following list for Westphalia.—

A. Diptera. *Syrphidae*: 1. Rhingia rostrata *L.*, very common, skg.; 2. Volucella bombylans *L.*, freq., skg.; 3. V. haemorrhoidalis *Zett.*, one, skg.; 4. V. plumata *L.*, repeatedly, skg. **B. Hymenoptera.** *Apidae*: 5. Apis mellifica *L.* ☿, its proboscis being only 6 mm. long, it is unable to suck legitimately, and therefore it bites through the middle of the bell from outside and steals nectar through the hole; once skg. normally; 6. Bombus agrorum *F.* ♀ and ☿, very freq., skg., hanging on the bell from below and inserting its proboscis into the opening; 7. B. muscorum *F.* ♂, ♀ and ☿, do.; 8. B. rajellus *K.* ☿, do.; 9. B. sylvarum *L.* ♀ and ☿, do.; 10. B. terrester *L.* ♀, do., small ☿ alternately perforate the bells and steal nectar, and suck legitimately; 11. Nomada solidaginis *Pz.* ♂, once, apparently vainly skg. **C. Lepidoptera.** *Noctuidae*: 12. Plusia gamma *L.*, in enormous numbers, skg. **D. Thysanoptera.** 13. Thrips, freq.

Knuth observed the following in Schleswig-Holstein.—

A. Diptera. *Syrphidae*: 1. Eristalis sp.; 2. Helophilus pendulus *L.*; 3. Volucella bombylans *L.* **B. Hymenoptera.** *Apidae*: 4. Andrena pubescens *K.* ♀; 5. Apis mellifica *L.*; 6. Bombus agrorum *F.*; 7. B. cognatus *Steph.*; 8. B. derhamellus *K.*; 9. B. distinguendus *Mor.*; 10. B. lapidarius *L.*; 11. B. terrester *L.* **C. Lepidoptera.** (*a*) *Noctuidae*: 12. Plusia gamma *L.* (*b*) *Rhopalocera*: 13. Epinephele janira *L.* (*c*) *Sphingidae*: 14. Zygaena filipendulae *L.*

On July 26, 1897, Knuth observed many honey-bees, skg. legitimately near Norddorf in the island of Amrum. Although their proboscis is only 6 mm. long, while the bells were 7 mm. in length, they must have obtained plenty of nectar, for they flew steadily from flower to flower, remaining several seconds on each. Some of them now and then examined the bases of the flowers, obviously for the purpose of biting a hole through which to steal nectar, but few actually did this, as for the most part they went back to the mouth of the corolla and continued to suck normally.

Alfken records the following for Bremen.—

A. Diptera. *Muscidae*: 1. Echinomyia grossa *L.* **B. Hymenoptera.** (*a*) *Apidae*: 2. Bombus derhamellus *K.* ☿; 3. B. distinguendus *Mor.* ♀; 4. B. jonellus *K.* ☿; 5. B. lucorum *L.* ☿; 6. B. muscorum *F.* ☿; 7. B. terrester *L.* ☿; 8. B. variabilis *Schmiedekn.* ☿; 9. Halictus lineolatus *Lep.* (= H. canescens *Schenck*) ♀; 10. Megachile analis *Nyl.* ♀ and ♂; 11. M. circumcincta *K.* ♀ and ♂; 12. Psithyrus campestris *Pz.* ♀. (*b*) *Sphegidae*: 13. Mellinus arvensis *L.* ♀ and ♂, skg.

The following were recorded by the observers, and for the localities stated.—

Wüstnei (Sylt), the bee Andrena nigriceps *K.* Smith (England), the bee Podalirius bimaculatus *Pz.* Willis and Burkill (Central Wales), a butterfly (Coenonympha pamphilus *L.*, skg.) and 3 humble-bees—1. Bombus agrorum *F.*, skg.; 2. B. lapidarius *L.*, skg.; 3. B. terrester *L.*, skg. ('Fls. and Insects in Gt. Britain,' Part I). Willis (op. cit.) (neighbourhood of south coast of Scotland), 3 bees—1. Apis mellifica *L.*, freq., skg.; 2. Bombus agrorum *F.*, very common, skg.; 3. B. hortorum *L.*, freq., skg. Scott-Elliot (Dumfriesshire), Apis, 3 humble-bees, a Muscid, and a hover-fly ('Flora of Dumfriesshire,' p. 113).

1764. E. cinerea L. (Ogle, Pop. Sci. Rev., London, ix, 1870, p. 170; Powell, J. Bot., London, xxii, 1884, pp. 278–9; Schulz, 'Beiträge.')—Ogle says that the flower mechanism of this species entirely agrees with that of E. Tetralix. Powell and Schulz both state that the bells are sometimes perforated by humble-bees.

Visitors.—Willis observed the following in the neighbourhood of the south coast of Scotland ('Fls. and Insects in Gt. Britain,' Part I).—

A. Diptera. (*a*) *Muscidae*: 1. Trichophticus cunctans *Mg.*, po-dvg.⁻ (*b*) *Syrphidae*: 2. Platycheirus albimanus *F.*, skg. **B. Hymenoptera.** *Apidae*: 3. Apis mellifica *L.*, very common, skg.; 4. Bombus agrorum *F.*, do.; 5. B. lapidarius *L.*, do.; 6. B. latreillellus *K.* (=B. distinguendus *Mor.*), skg.; 7. B. pratorum *L.*, freq., skg.; 8. B. terrester *L.*, do.; 9. Psithyrus campestris *Pz.*, skg. **C. Lepidoptera.** *Rhopalocera*: 10. Epinephele janira *L.*, freq., skg.

The following were recorded by the observers, and for the localities stated.—

Willis (Central Wales) (op. cit.), 2 humble-bees (Bombus agrorum *F.*, skg., and B. terrester *L.*, do.) and 2 butterflies (Polyommatus phlaeas *L.*, skg., and Vanessa urticae *L.*, do.). Scott-Elliot (Dumfriesshire), Apis, 7 humble-bees, a short-tongued bee, and 2 hover-flies ('Flora of Dumfriesshire,' p. 112).

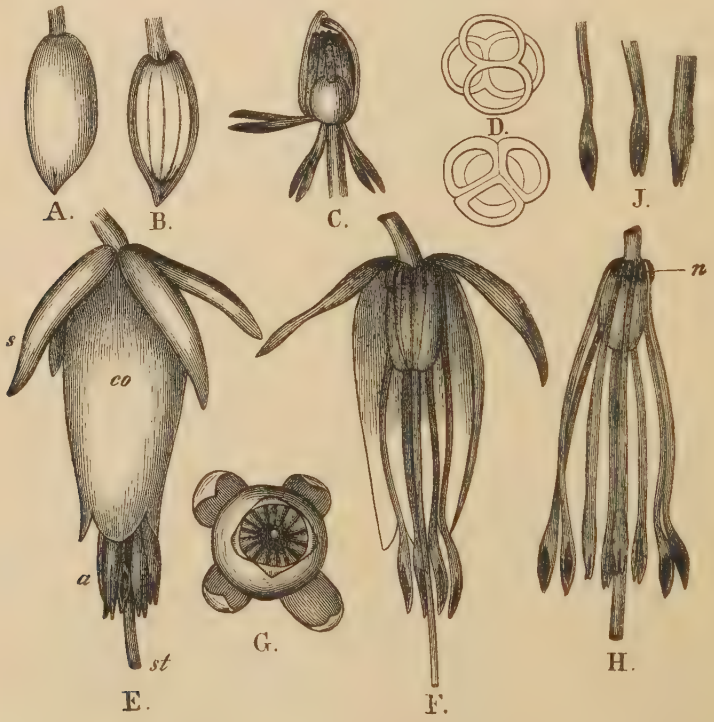


FIG. 226. *Erica carnea*, *L.* (after Herm. Müller). *A.* A next year's flower-bud (× 7). *B.* Do., after removal of two sepals. *C.* Do., after removal of the calyx and front part of the corolla, and forcible bending back of three stamens (× 7). *D.* Pollen-tetrads from a bud (greatly enlarged). *E.* A flower, seen from the side (× 7). *F.* Do., after removal of part of the calyx and corolla and some of the stamens. *G.* Flower seen from below. *H.* Reproductive organs and nectaries. *J.* Anthers seen from the side, from within, and from without (× 7). *a*, anthers; *co*, corolla; *n*, nectaries; *s*, sepals; *st*, stigma.

1765. E. scoparia L. (Malpighia, Genova, iv, 1890.)—Delpino describes this species, native to South Europe, Dalmatia and France, as anemophilous.

1766. E. arborea L. (Knuth, 'Blütenbiol. Beob. a. d. Ins. Capri,' p. 11.)—I have not seen fruits set by this species in Capri. In April the sticky stigmas still projected from the flowers, though the anthers had all shed their pollen.

Visitors.—Schletterer (Pola), 2 bees (Andrena carbonaria *L.*, numerous, and A. morio *Brull.*, freq.) and a wasp (Polistes gallica *L.*).

1767. E. carnea L. (Herm. Müller, 'Alpenblumen,' pp. 382–5.)—Although the flowers of this species possess a bell-shaped corolla with its opening directed downward, Hermann Müller says they are adapted to the visits of butterflies and not to those of bees. That they belong to class **Lb** is shown by their beautiful red colour, and the narrow mouth of the corolla, which is so completely filled up by the stamens that only the thin proboscis of a Lepidopterid can make its way past or between them.

By summer or autumn the next year's flowers are developed as green buds, and Linnaeus even described plants in this condition as a distinct species E. herbacea. When the snow has melted, therefore, blossoming can at once take place. The flowers are rendered conspicuous, not only by the bright-red calyx and corolla, but also by the still more vividly coloured flower-stalks and the strongly exserted red style. The dark-brown anthers, devoid of appendages, are also exserted, so that insects flying to the flowers first touch the stigma, and then strike against the anthers, which dust them with pollen tetrads. Automatic self-pollination is excluded, for the stigmatic tip of the style is not capitate but truncate. Kerner says that as in Calluna the flowers are pollinated by the wind towards the end of anthesis.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), almost exclusively a butterfly (Vanessa cardui *L.*), but humble-bees very occasionally. A. Schulz (Tyrol) noticed the latter more frequently ('Beiträge'). Friese (Innsbruck), the bee Osmia bicolor *Schr.* ♂ and ♀, skg.; (Fiume), the bee Andrena extricata *Sm.* Knuth (Kiel Botanic Garden), the humble-bee Bombus hortorum *L.*, skg.

525. **Bruckenthalia** Reichb.

Bell-shaped nectarless flowers; entomophilous and anemophilous.

1768. B. spiculifolia Reichb. (=Erica Bruckenthalii *Spreng.*). (Loew, 'Blütenbiol. Floristik,' p. 269.)—This species is native to Greece, the Siebengebirge, and Hungary. Loew investigated plants cultivated in the Berlin Botanic Garden, and gives the following account.—

The small pink flowers possess rounded bells about 3 mm. long and 2 mm. broad, which are arranged in small racemes 1½ cm. in length. The style projects for about 2 mm. from the throat of the corolla, which is completely filled by the brown anthers. These are devoid of appendages, and borne on slender filaments, the bases of which are connected into a narrow ring. The anther-pores are downwardly directed, and the pollen is extremely powdery, while its grains are not united into tetrads. The round red stigma becomes receptive before the anthers dehisce, and its surface bears four secretory punctiform projections. It is protected against falling pollen-grains by its position. Pollination seems to be largely effected by the wind, as well as by insects.

4. Tribe Rhodoreae.

Homogamous or protogynous flowers, belong to the classes **E, EC,** and **H.**

526. Phyllodoce Salisb.

Ovoid, usually pendulous, blue or red bee flowers; concealed nectar, secreted by a yellow crenate ring at the base of the ovary.

1769. P. taxifolia Salisb. (=P. caerulea *Bab.*, Erica caerulea *Willd.*, E. arctica *Waitz* and Bryanthus taxifolius *A. Gray*). (Warming, Bot. Tids., Kjöbenhavn, xv, 1885, pp. 20–5.)—Warming describes this northern species as feebly protogynous in Greenland. The length of the style is variable, and the stigma becomes sticky in the bud. In short-styled flowers the stigma and anthers are at the same level, so that automatic self-pollination is inevitable. The generally pendulous position of the flowers, and the narrow opening of the corolla, suggest adaptation to pollination by bees, but these have not so far been observed. Bessel only saw a butterfly (Colias boothii *H.-Sch.* =C. hecla *Lef.*). (*Cf.* Fig. 227.)

Fig. 227. *Phyllodoce taxifolia*, *Salisb.* (after E. Warming). Drawn from Greenland specimens (*A*, *B*, *C*, *D*. × 2½). *A*. A young flower, just opened; there are already some pollen-grains on the stigma. The hairs on the flower and pedicel are omitted. *B*. Another flower, in which anthers and stigma are at the same level. Most of the stamens have been removed. *C*. A third young flower, in which the anther-pores and stigma are at the same level, approximately between the upper and middle thirds of the corolla. *D*. Do., seen from the mouth of the bell. *E*. Pistil and nectary, seen *en face*. *F*. A stamen, seen from the front. *G*. A pollen-tetrad. *H*. Base of the pedicel, with bracteoles.

The mechanism of the flowers examined by Lindman on the Dovrefjeld agreed essentially with that of Greenland specimens, but a form was observed with a style only 2 mm. long, so that the anthers projected beyond the stigma, excluding the possibility of self-pollination.

Ekstam found the species to be protogynous-homogamous in the Swedish Highlands.

The specimens collected by Vanhöffen in Greenland mostly possessed homostylous flowers, and fruits were set there at the end of July or the beginning of August (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' p. 48).

527. Ledum Rupp.

Flowers white or rose-red in colour, homogamous or feebly protogynous, arranged in umbels; nectar half-concealed, secreted at the base of the ovary.

1770. L. palustre L. (Warming, Bot. Tids., Kjöbenhavn, xv, 1885, pp. 39–44; Loew, 'Blütenbiol. Floristik,' p. 271; Knuth, 'Bloemenbiol. Bijdragen.')—

In this species the entire plant possesses a strong aromatic odour. The white or rose-red petals are expanded to form a flat surface. Nectar is secreted by a ten-lobed swelling at the base of the ovary, and is easily accessible, although it is protected by hairs situated above the bases of the stamens. Warming describes the species as feebly protogynous in Greenland and Norway, though automatic self-pollination appears to be effected in the bud. The anthers are borne on long filaments, and are strongly exserted at a later stage.

Unfortunately I did not carefully investigate the plants of this species I saw on Wollin I., but have frequently watched for visitors there, and noticed a Muscid (Sarcophaga carnaria *L.*). I have, however, examined the mechanism of specimens growing in the Kiel Botanic Garden, and this is as follows.—

The flowers are homogamous, but the stigmas are persistent, remaining receptive after all the pollen has been shed. The diverging filaments are 6 mm. long, and the stigma is placed about a mm. lower. Automatic self-pollination by the fall of pollen is therefore possible in lateral flowers.

Abromeit gives the following description of the var. *β decumbens* Ait., for West Greenland ('Bot. Ergeb. von Drygalski's Grönlandsexped.,' pp. 58–9).—The inflorescences are covered with woolly white or brown hairs, and bear 12–15 white flowers, which differ essentially from those of Rhododendron in the absence of a corolla-tube, and have pedicels as much as 14 mm. long. The petals are about 5 mm. long and 3 mm. broad. The ten long filaments are broadened at their bases, and pollen falls very easily from the small white anthers upon the glutinous stigma which is placed at a lower level.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Warming (Jakobshavn) on the var. *β decumbens*, a butterfly (Argynnis chariclea *Schneid.*). Knuth (Wollin I.), the Muscid Sarcophaga carnaria *L.*: (Kiel Botanic Garden), the hover-fly Syritta pipiens *L.*, po-dvg., and only occasionally touching the stigma—also in many flowers sticking to the style and ovary, 15–20 of these were often found in the some 20 flowers of an umbel, adhering so closely that they could not be separated without tearing; they would almost seem to have been digested by the plant, for their shape ultimately became unrecognizable, and only blackish chitinous masses remained.

1771. L. latifolium Jacq. (=L. groenlandicum *Retz.*). (Warming, Bot. Tids., Kjöbenhavn, xv, 1885, pp. 39–44.)—This reputed species is perhaps only a variety of L. palustre, and Warming says that its flower mechanism is the same, though homogamy undoubtedly obtains. The anthers dehisce in the bud. Both self- and cross-pollination are possible, and may be effected not only by insects, but also by the wind, which is able to transfer pollen to the stigma of the same or adjacent flowers.

528. Azalea L.

Flowers protogynous, rose-red in colour, arranged in umbels containing only a few blossoms; exposed nectar, secreted by a ring at the base of the ovary.

1772. A. procumbens L. (=Loiseleuria procumbens *Desv.*). (Ricca, Atti Soc. ital. sc. nat., Milano, xiv, 1871; Kerner, 'Nat. Hist. Pl.,' Eng. Ed., I, II, p. 337;

Lindman, 'Bidrag till Känned. om Skandin. Fjellväxt. Blomn. o. Befrukt.': Warming, 'Bestövningsmaade,' pp. 6–7, Bot. Tids., Kjöbenhavn, xv, 1885: Herm. Müller, 'Alpenblumen,' pp. 171–2, 377–8.)—In this species an insect, when inserting its head or proboscis between the ovary and stamens in order to reach the nectar, will touch the pollen-covered inner surfaces of the anthers with one side and the stigma with the other side, and flying from flower to flower will effect crossing, which is also favoured by the slight protogyny of the species. Automatic self-pollination can also no doubt take place, during bad weather, in flowers which close or have not yet opened. Kerner states that the stamens bend towards the stigma and bring this about, also that the plant may be pseudo-cleistogamous in bad weather. Lindman on the Dovrefjeld also noticed self-pollination by bending of the stamens towards the stigma. There, as in Greenland, Finmark, and Nordland, the flowers are at first feebly protogynous, and then homogamous. Warming noticed that in the three localities mentioned the anthers are situated nearer the stigma than in alpine habitats, and are frequently in actual contact with it. Automatic self-pollination consequently predominates, and appears to be effective. Ekstam describes the flowers as homogamous in the Swedish Highlands. Ricca, on the other hand, in the Val Camonica, found the flowers to be so strongly protogynous that the stigmas were usually completely dried up before the anthers dehisced.

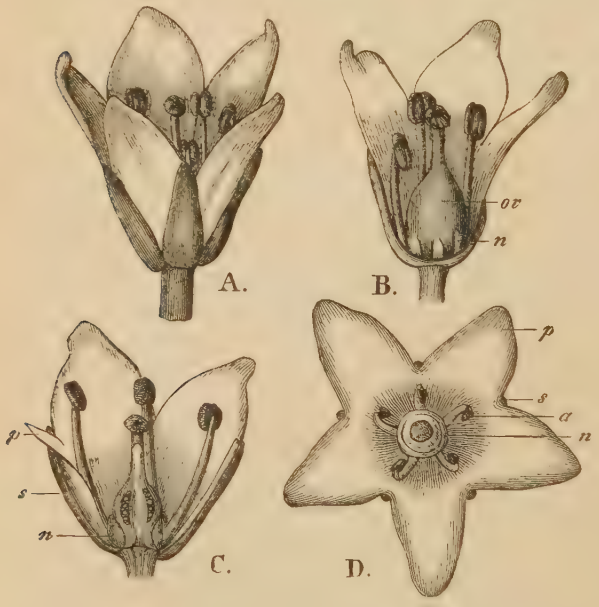


FIG. 228. *Azalea procumbens*, *L.* (after Herm. Müller). *A*. A flower in the first (female) stage. *B*. Do., partly dissected. *C*. A flower in the second (hermaphrodite) stage. *D*. Do., in the third (male) stage. *a*, anthers; *n*, nectaries; *ov*, ovary; *p*, petals; *s*, sepals.

Greenland specimens collected by Vanhöffen and von Drygalski possessed extremely small flowers only 5–6 mm. in diameter, and feebly protandrous (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' p. 49).

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 3 flies, 2 humble-bees, and 5 Lepidoptera ('Alpenblumen,' p. 378); also 7 flies, 2 humble-bees, an ant, and 5 Lepidoptera (op. cit., p. 172). Warming (Greenland), small flies. Wormskjold (Greenland), Lepidoptera.

529. Rhododendron L.

Protandrous humble-bee flowers, usually brightly coloured; nectar secreted by an annular swelling at the base of the ovary. Kerner states that in many species the pollen-tetrads are bound together by threads of viscin.

1773. R. ferrugineum L. (Ricca, Atti Soc. ital. sc. nat., Milano, xiii; Herm. Müller, 'Alpenblumen,' pp. 378–9.)—In this species the abundant nectar collects in the base of the almost horizontal corolla-tube, especially in a slight pouch on the upper side of this. The erect hairs on the filaments serve as nectar-covers. In

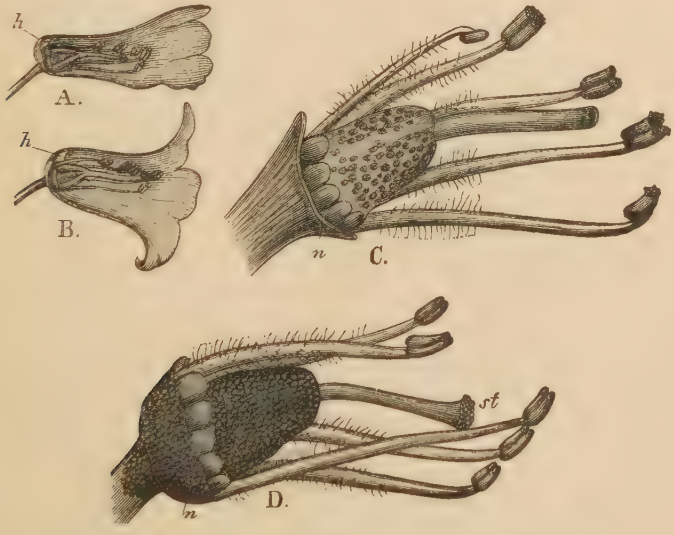


FIG. 229. *Rhododendron*, *L.* (after Herm. Müller). *A.* A just-opened flower of *R. ferrugineum*, *L.* (natural size). *B.* A rather older flower of the same species. *C.* A young flower of *R. hirsutum*, *L.* (in the male stage), after removal of the perianth and some of the stamens (× 7). *D.* An older flower of the same species (in the female stage), treated similarly (× 7). *h*, nectar; *n*, nectary; *st*, stigma.

order to get at the nectar-bees and humble-bees must creep over the stamens and stigma into the base of the flower, and if this is in the first stage their under-side is dusted with pollen, which will be transferred to the stigmas of flowers in the second stage. As the longest stamens project beyond the stigma, automatic self-pollination is possible if insect-visits fail.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), the honey-bee and 7 humble-bees, skg. legitimately and effecting cross-pollination; also, as unbidden guests, a beetle, 4 flies, an ant, and 9 Lepidoptera. Ricca (Alps), humble-bees up to a height of 2,200 m. MacLeod (Pyrenees), 3 humble-bees, Halictus, and a Muscid (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 373).

1774. R. hirsutum L. (Herm. Müller, op. cit.)—Hermann Müller says that the flower mechanism of this species completely agrees with that of R. ferrugineum. Hansgirg noticed the occurrence of pseudo-cleistogamy.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), almost the same insects as for R. ferrugineum. Frey-Gessner (Switzerland), 5 bees—1. Bombus alpinus *L.* ♀; 2. B. mastrucatus *Gerst.*; 3. B. mendax *Gerst.*; 4. B. montanus *Lep.*; 5. Osmia nigriventris *Zett.* (= O. criticalis *Gerst.*). Schletterer (Tyrol), the humble-bee Bombus pratorum *L.*

1775. **R. lapponicum** Wahlenb. (Warming, Bot. Tids., Kjöbenhavn, xv, 1885, pp. 35–9.)—Warming says that in the homogamous Hymenopterid flowers of this species the stamens diverge so much laterally that the anthers are scarcely likely to touch the stigma, so that self-pollination is rendered very difficult, and crossing is usually necessary. He noticed many ripe fruits.

The flowers of the specimens collected by Vanhöffen (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' pp. 49–51) in Greenland were situated in groups of 2–4 at the ends of the branches, and surrounded in the bud by glandular scale-leaves covered with a felt of woolly hairs. When the flowers open their stalks are very short (5 mm.) and beset with numerous yellow glands, but subsequently elongate to 10–14 mm. The calyx is purple-red in colour, also glandular, and the edges of its teeth fringed with long hairs. The total length of the corolla is 8–8·5 mm., of which about half is taken up by the tube; it is dark purple-red or sometimes bright pink in colour, and its throat is lined with small hairs. There are five to nine stamens, equal in length to the pistil, and usually widely separate from one another. The bases of the filaments are broadened and covered with small hairs, and the brown-red anthers dehisce by means of two rounded apertures. The style is 8–11 mm. long, and the dark purple-red stigma is extremely glutinous. Nectar is secreted by a hypogynous ring.

1776. **R. praecox.**—This species is native to the Himalayas.

Visitors.—Knuth (Kiel Botanic Garden) saw 2 bees, skg. (Apis mellifica *L.* ♀, and Bombus terrester *L.* ♀).

1777. **R. Chamaecistus** L. (=Rodothamnus Chamaecistus *Reichb.*).—The rose-red corolla of this species is not funnel-shaped as in the preceding ones, but wheel-shaped. Kerner states that the protogynous flowers are inevitably cross-pollinated in the first stage of anthesis. The filaments can be twisted round, and are used as alighting-rods by insects, which transfer pollen to the stigmas of blossoms in the first stage, while in those in the second-stage they rub off the pollen-tetrads which are united together by threads of viscin. Ultimately the flower sinks down till the stigma is brought into the line of fall of the pollen, rendering automatic self-pollination possible.

1778. **R. Vanhoeffeni** Abrom.—Vanhöffen found only a single plant of this species in Greenland, which was growing between thick clumps of Vaccinium uliginosum and Betula nana. In some respects it appears to be closely related to R. lapponicum, in others to Ledum palustre *L.*, var. *β decumbens* Ait., so that it is possibly a hybrid between them. It is distinguished from R. lapponicum by more numerous flowers in the inflorescence, longer pedicels, a smaller corolla less deeply cleft and with a tube only 1–2·5 mm. long, as well as by a series of vegetative

characters. The pollen-grains are smaller, and their walls often shrivelled (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' pp. 51–8). The stamens are usually ten in number, and project a little beyond the style. Some of the brownish or yellowish anthers appear to be reduced.

530. Rhodora L.

Flowers homogamous, with concealed nectar; the stigma is at first covered as with a cap by the middle lobe of the upper lip.

1779. R. canadensis L. (=Rhododendron Rhodora *J. F. Gmel.*). (Hildebrand, Flora, Marburg, xxxix, 1881.)—Hildebrand gives the following account of this species.—

The corolla possesses two lower lobes separate almost to the base, and a three-lobed upper lip, the central division of which covers the opening of the flower like a cap, holding fast the elongating style so that it is bent sharply downwards at its centre. There are ten stamens, of which the upper ones are shorter with tips bent downwards, while the longer lower stamens are bent upwards. The anthers are so placed that their apical pores surround the opening of the flower, so that an insect visitor must dust itself with the pollen by which these are covered. The continued elongation of the style causes it to spring out of the cap at a later stage, and it now projects beyond the anthers so that an insect visiting the flower must first touch it, securing cross-pollination if already dusted in another flower. Autogamy is not absolutely excluded, but as visitors have usually removed all the pollen before the stigma emerges, it is generally impossible.

531. Kalmia L.

The anthers are situated in pouches of the corolla, and the elasticity of the filaments causes them to spring out when insects visit the flower. Drude gives the following description of the mechanism (in Engler and Prantl, 'D. nat. Pflanzenfam.,' IV, 1, p. 25).—

The anthers are enclosed in pits of the wheel-shaped corolla, the margins of which prevent them springing out prematurely, though the filaments are strongly bent inwards and in a state of elastic tension. In warm sunshine the elasticity of the filaments increases, and they perhaps become shorter, so that the slightest touch causes them to spring out and scatter a cloud of pollen from their dehisced anthers. Drude's observations were made in the Dresden Botanic Garden, where he never saw the liberation effected by insects, which curiously did not appear to visit the bright red flowers. In favourable weather it took place spontaneously, and was followed in due course by the formation of seeds. The pollen reaches the stigmas of neighbouring flowers much more easily than that of the one in which it is produced, but autogamy is not excluded.

1780. K. glauca Ait. (=K. polifolia *Wangen.*). (Sprengel, 'Entd. Geh.,' pp. 238–40; Delpino, 'Ult. oss.,' p. 169; Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870, p. 669; W. J. Beal, Amer. Nat., Boston (Mass.), i, 1868.)—Sprengel supposed the flower mechanism of this species to be adapted to self-pollination. Delpino and

Hildebrand think that insects are driven away by the explosion of the stamens, and transfer the pollen to other flowers. W. J. Beal says that the flowers are self-sterile.

Visitors.—W. J. Beal observed the honey-bee, bringing about the explosion, and effecting crossing.

5. Tribe Pyroleae.

Flowers usually homogamous, with or without nectar.

532. Pyrola L.

Flowers generally white in colour; nectar abundantly secreted in their bases, or absent. Pollen-grains in tetrads. Anthers dehisce by pores. Flowers arranged in radial racemes, or rarely solitary.

1781. P. minor L. (Ricca, Atti Soc. ital. sc. nat., Milano, xiii, 1870; Warming, Bot. Tids., Kjöbenhavn, ii, 1877, pp. 122–4; Herm. Müller, 'Alpenblumen,' pp. 376–7; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 452.)—Ricca describes the nectarless flowers of this species as protandrous, but Warming, MacLeod and myself found them to be homogamous. The five stigmatic lobes abundantly secrete a sticky fluid, which in the absence of nectar appears to be licked by insect visitors before they search for

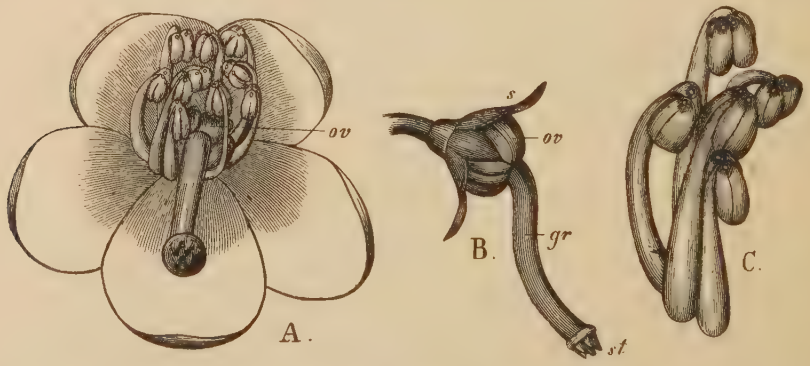


Fig. 230. *Pyrola rotundifolia L.* (after Herm. Müller). *A.* Flower, seen immediately from the front (× 3½). *B.* Pistil, seen from the side. *C.* Stamens (× 7). *gr*, style: *ov*, ovary; *s*, calyx; *st*, stigma.

pollen, so that their visits effect crossing. The anthers are erect in the bud, but afterwards turn over, so that their basal pores, of which the margins are orange-red, are directed downwards. Automatic self-pollination regularly takes place, should insect-visits fail, by fall of pollen on the reflexed margin of the stigma. Warming observed flowers of different size and breadth:—in some the petals come together to form a globular bell with narrow aperture, and the stamens are relatively long; in others the corolla is more widely open, and the stamens are shorter. Warnstorf describes the pollen-tetrads as four-sided, and 30–44 μ in diameter.

Visitors.—Very few. The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Westphalia), a beetle (Dasytes flavipes *F.*), constantly present in large numbers, first visiting the stigma, then the stamens, and thus effecting crossing;

also some small flower-beetles (Meligethes sp.) and 2 Muscids (Anthomyia sp., and Opomyza germinationis *L.*). Scott-Elliot (Dumfriesshire), a humble-bee, a Muscid, a micro-Lepidopterid, and a beetle ('Flora of Dumfriesshire,' p. 113).

1782. P. rotundifolia L. (Warming, op. cit., p. 124; Herm. Müller, op. cit., p. 376; Lindman, 'Bidrag till Känned. om Skandin. Fjellväxt. Blomn. o. Befrukt.'; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.' pp. 102–3; Warnstorf, Schr. natw. Ver., Wernigerode, xi, 1896, p. 7.)—The flowers of this species examined by me at Kiel were white in colour with an open bell-shaped corolla, devoid of nectar, feebly odorous, and homogamous (strongly protandrous according to Warnstorf. Their mechanism is at first adapted to crossing, and subsequently, as a rule, to automatic self-pollination. This change is brought about by a gradual alteration in the direction of growth of the style, which is at first directed almost vertically downwards, sometimes with a slight upward curve, so that the line of fall of the pollen is about 8 mm. in front of the stigma. The end of the style subsequently bends upwards, bringing the stigma vertically below the opening of the anthers, so that autogamy follows automatically by the fall of pollen (Fig. 231). Lindman says that in plants growing on the Dovrefjeld automatic self-pollination finally becomes possible, for the anther-pores, at first basal, are brought into a suitable position.

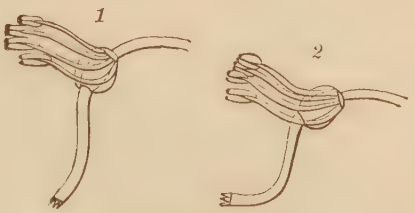


FIG. 231. *Pyrola rotundifolia*, *L.* (from nature). (1) Stamens and pistil in the first condition of the flower; the stigma is not in the line of fall of the pollen. (2) Do., in the second stage of anthesis; the stigma lies vertically below the tips of the anthers, from which the pollen is distributed.

In this species again the stigma secretes a large amount of sticky fluid, from which five conical elevations project, and the pores of the yellow anthers are surrounded by an orange-yellow band. Warnstorf states that the pollen-tetrads are 37 μ in diameter.

VISITORS.—These are very few in number. On the Meimersdorfer Moor near Kiel, where this plant grows in association with Parnassia palustris, I observed large numbers of insects visiting the latter (11 and 14. 9.'92), but, though I watched for a long time, was unable to see a single insect visiting the Pyrola, though it was quite as conspicuous. On flowers taken into my study I noticed several house-flies, touching the stigmas, anthers, and petals with their proboscis, but after a few vain attempts to find nectar they quickly went away again. Alfken observed no visitors in Norderney.

Warming has examined herbarium specimens of the var. *arenaria* Koch in which the stigma and anthers are closer together than in the type-form, so that automatic self-pollination would appear to be effected more easily.

VISITORS.—Verhoeff observed none in Norderney.

1783. P. grandiflora Rad. (Kolderup Rosenvinge, Meddel. om Grönland, xv, 1896, p. 68; Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' p. 48.)—Rosenvinge states that there are transitions between this arctic species and P. rotundifolia. The Greenland specimens described by Abromeit possess an external annular swelling at the base of the calyx which is absent in the latter, while the calyx-teeth are shorter (usually less than half that of the petals), broader, and often dentate at their ends.

1784. P. media Sw. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II.)—Kerner says that automatic self-pollination is brought about in the white flowers of this species by a bending of the style, by which the stigma is brought into contact with pollen lying in depressions of the petals.

1785. P. secunda L. (Kerner, op. cit., p. 274; Ricca, Atti Soc. ital. sc. nat., Milano, xiv, 1871; Warnstorf, Schr. natw. Ver., Wernigerode, xi, pp. 7–8.)—Kerner says that in this species nectar is secreted at the base of the corolla in the pendulous flowers. The anther-pores face upwards, and the **S**-shaped filaments are kept in place by the petals. When a nectar-seeking insect touches the stamens the anthers tip over, so that the pollen falls upon and dusts it. This pollen is then transferred to the stigma of the next flower visited.

Ricca describes the flowers as feebly protogynous, and Warnstorf also says they are protogynous. During the first (female) stage of anthesis the thick glutinous stigma projects about 2 mm. from the flower-bell, while the white pubescent anthers, borne on **S**-shaped filaments, are first closed, but afterwards dehisce on the side turned inwards. If the proboscis of an insect is inserted into the flower at this stage, the anthers tip over and discharge their mealy white pollen on the head of the visitor, to be transferred to the projecting stigma of the next flower visited. Should insect-visits fail, the filaments straighten themselves, and the anthers project from the flower, the opening of which is widened by the pressing back of the petals. The anthers now tip over of their own accord, and the pollen is able to fall on the stigmas of lower flowers. The pollen-grains are smooth, ellipsoidal, about 25 μ long and 12 μ broad.

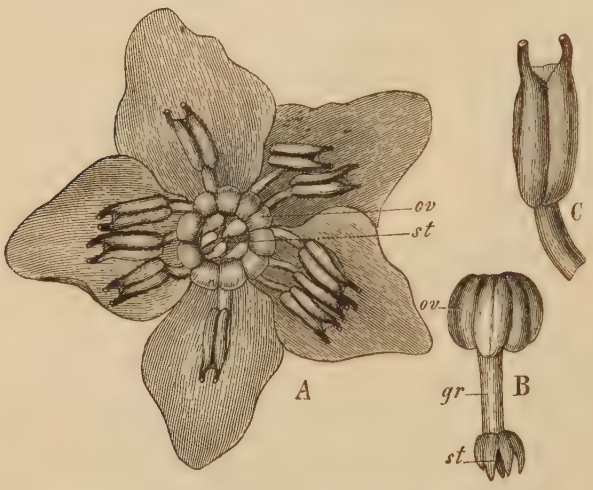


FIG. 232. *Pyrola uniflora*, *L.* (after Herm. Müller). *A*. Flower seen directly from below (× 3). *B*. Pistil of same, seen from the side (× 3). *C*. An anther (× 7). *gr*, style; *ov*, ovary; *st*, stigma.

1786. P. uniflora L. (=Moneses grandiflora *S. F. Gray*). (Ricca, Atti Soc. ital. sc. nat., Milano, xiv, 1871; Herm. Müller, 'Alpenblumen,' pp. 375–6; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 383; Warming, Bot. Tids., Kjöbenhavn, xv, 1895, pp. 15–18; Lindman, 'Bidrag till Känned. om Skandin. Fjellväxt. Blomn. o. Befrukt.')—The large white nectarless flowers of this species are turned downwards, and as they expand to a breadth of 20 mm. are tolerably conspicuous, though only one is situated at the end of each peduncle. The lowest part of the flower is the most convenient alighting-platform, and this is constituted by the five sharp lobes of the

stigma, upon which are damp glistening spots (considered as nectar by Ricca), that visitors lick, at the same time depositing any pollen adhering to their proboscis. Finding no nectar they climb up the style, attracted by the orange-yellow horns of the anthers, and busy themselves with the pollen, so that the proboscis is again dusted. Crossing is therefore easily effected by insects, but Hermann Müller says that the projecting position of the stigma usually prevents automatic self-pollination. Kerner gives a different account. He says that at first the peduncle is bent in such a way that the style projects vertically downwards, while the anther-pores face upwards, autogamy being therefore impossible. Insect visitors first touch the stigma, and then tip over the anthers, which sprinkle them with pollen. Later on the peduncle becomes less bent, so that the flower is brought into a nodding position, while the style is directed obliquely downwards and the stigma now lies directly below the anthers. At the same time the filaments have bent round, so that the anther-pores face downwards, and pollen can easily fall from them upon the stigma, automatically effecting self-pollination.

FIG. 233. *Pyrola uniflora*, *L.* (after E. Warming). *A.* Flower seen from the side. *B.* Do. from the front (× 2). *C.* Flower-bud sheltered by a bract. *D*, *E*, *F.* Stamens of an older flower (× 8). *G.* Stigma seen from above. *H*, *I.* Stamens of a bud, before they have turned round (× 8). *K.* Flower of *P. rotundifolia*, *L.* (× 2).

Warming says that in plants growing in Greenland the distance between the stigma and anthers is less than in P. rotundifolia, so that automatic self-pollination is more easily effected. (*Cf.* Fig. 233.) According to Lindman, the flowers on the Dovrefjeld have a smaller diameter (13 mm.) than those of the Alps. Ekstam says that the diameter varies from 12 to 20 mm. in the Swedish Highlands, while that of the faintly odorous flowers of Nova Zemlia is 10–20 mm. The mechanism in the latter locality agrees with the description given by Warming, and sometimes suggests that of P. rotundifolia. No nectar is secreted.

533. Hypopitys Dill.

Homogamous flowers with concealed nectar, secreted, according to Kerner, by the fleshy base of the corolla.

1787. H. multiflora Scop. (=Monotropa hypopitys *L.*). (Kirchner, 'Flora v. Stuttgart,' p. 530; Warnstorf, Verh. bot. Ver., Berlin, xxxvii, 1896.)—The flowers of this species, which like the whole of the plant are pale-yellow in colour, are homogamous and arranged in racemes. The terminal one is pentamerous, and the lateral

ones tetramerous. Kirchner states that the former has ten, while the latter have eight small narrow nectaries at the base of the ovary, which project into gibbosities of the petals that serve as nectar-receptacles. The erect dentated petals are about 15 mm. long, and closely apposed laterally, so as to contract the opening of the flower to 4–5 mm. This is almost blocked up by the large capitate stigma, which is 3–3½ mm. broad. A proboscis at least 10 mm. long is required to reach the nectar. There is a central pit in the stigma, surrounded by a wall of very sticky papillae and the lower side of the stigma is surrounded by whitish hairs which help to prevent self-pollination. The anthers are situated rather below the stigma at the level of these hairs, and dehisce extrorsely. Insect visitors must first touch the stigma with their heads, dusting it with pollen if they have previously visited another flower, and at the same time making their head or proboscis sticky with stigmatic fluid, so that the white pollen against which they at once brush will adhere to them. Crossing is thus ensured, while automatic self-pollination would seem to be excluded. Warnstorf describes the pollen-grains as white in colour, spheroidal, smooth, and about 25 μ in diameter.

Visitors.—I observed the humble-bee Bombus agrorum *F.* ♀, skg. (length of proboscis 10–15 mm.) on Wollin Island.

LXI. ORDER *EPACRIDEAE* R. BR.

Delpino ('Ult. oss.') says that some of the species of the genus Epacris are protogynous.

534. Richea R. Br.

1788. R. sprengelioides F. Muell. (= Cystanthe sprengelioides *R. Br.*). (Borzi, 'Contrib. alla biol. veget.,' II, Fasc. 1, Palermo, 1897.)—Borzi says that this species is anemophilous.

LXII. ORDER *DIAPENSIACEAE* LINDL.

535. Diapensia L.

1789. D. lapponica L. (Warming, 'Bestövningsmaade,' pp. 34–6.)—This species, native to high latitudes, is said by Warming to be feebly protogynous in Greenland. The stigma and anthers are tolerably far apart, so that automatic self-pollination is rendered difficult, but sometimes the anthers dehisce in the bud, so that autogamy can take place when the flower opens. Nectar is abundantly secreted at the base of the ovary, and is completely concealed.

Lindman states that the flowers are protogynous on the Dovrefjeld. The stamens are at first curved inwards, but afterwards become erect, though autogamy is excluded, for the flowers always remain erect, and the anthers project beyond the stigma.

Vanhöffen noticed (27.6.'93) fruiting plants in Greenland (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' p. 47).

Visitors.—Ekstam observed flies in the Swedish Highlands.

LXIII. ORDER *PLUMBAGINEAE* JUSS.

LITERATURE.—Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 122.

Flowers small but brightly coloured, and arranged in heads or corymbs. Nectar secreted and concealed in the bases of the flowers, which therefore belong to class **C** or **S**. Fritz Müller states that many species of Plumbago and Statice are dimorphous (Bot. Ztg., Leipzig, xxvi, 1868, p. 113).

536. Armeria L.

1790. A. elongata Hoffm. (=A. vulgaris *Willd.*, Statice Armeria *L.*, and S. elongata *Hoffm.*). (Sprengel, 'Entd. Geh.,' pp. 174–5; Treviranus, Bot. Ztg., Leipzig, xxi, 1863; MacLeod, Bot. Centralbl., Cassel, xxix, 1887; Knuth, op. cit., xlviii, 1891, 'Vergl. Beob.,' 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 122–3, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 239, 'Bl. u. Insekt. a. d. Halligen'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 358; Schulz, 'Beiträge,' I, pp. 89–90.) — The plants of this species which I have investigated in the North Frisian Islands belong to a variety often reckoned as a distinct species (A. maritima *Willd.*). The flowers smell of cumarin, and the conical calyx, about 5 mm. in length, possesses a membranous limb of bright-violet colour like the corolla, and strengthened by five stiff teeth, the reddish tips of which enhance conspicuousness. The five corolla-lobes alternate with these teeth, are 8 mm. long and 5 mm. broad, and only connected at their bases. Each of them is traversed by a strong median vein of darker colour, and two weaker lateral ones. These lobes are held together by the calyx so as to constitute a funnel-shaped tube about 7 mm. deep. The stamens are 4–5 mm. long and opposed to the petals. Upon the top of the ovary there is a green five-rayed nectary, from the middle of which spring five styles equalling the stamens in length. The lower third of these is beset with erect white hairs, which are particularly long and numerous above, making up a dense feltwork serving as an effective protection to the nectar. The terminal third of the styles is beset with papillae giving a velvety surface. MacLeod says there is a nectary at the base of each petal.

FIG. 234. *Diapensia lapponica*, *L.* (after E. Warming). Drawn from material collected in Greenland. *A*. A widely open flower, seen from above, showing that the anthers are remote from the stigma. *B*. Corolla and stamens, seen from the side. *C*. Pistil and petal from the same flower. *D*, *E*. Pollen-grains. *F*. A young flower with corolla only partly expanded; the anthers have dehisced and there are some pollen-grains upon the stigma, which is already receptive; anthers and stigma are so close together that autogamy is probably easy. *G*. A young flower partly dissected; the anthers have opened and the stigma is receptive. *H*. Trifid style. (*A*, *B*, *C* × 2½; *G* × 3½.)

In the island of Sylt the flowers are feebly protandrous, indeed almost homogamous. The erect stamens dehisce as soon as the flowers open, so that insects

probing for nectar dust themselves with pollen. But as at the same time they touch the stigmas, automatic self-pollination necessarily takes place. According to MacLeod, however, the anthers have lost so much of their pollen as to render this difficult. Up to this time the outwardly bent styles alternate with the stamens, so that insect-visits are still able to effect crossing. MacLeod states that the stamens and styles ultimately become so intertangled that automatic self-pollination is inevitable. Insect visitors dust their upper sides with pollen if they probe for nectar between the corolla and stamens, but get covered all over with it should they creep into the base of the flower between the stamens.

The description of the method of pollination given by Schulz for the main form A. elongata does not entirely agree with the above account, possibly because it is sometimes difficult to distinguish between younger and older flowers. At first the styles bend outwards so as to touch the anthers, and as the flowers are homogamous autogamy is thus effected. The stamens first move inwards and then outwards. Towards the end of anthesis the styles and stamens become closely intertangled, but this does not lead to autogamy, for at this time there is often no pollen left, besides which the tips of the styles frequently project from the tangled mass. Kerner asserts, however, that automatic self-pollination does take place at this stage, styles and stamens being thrown into intertwining spirals.

FIG. 235. *Armeria*, *L.* (from a photograph, × 4). A flower, after corolla, stamens, and styles have fallen off, seen from above. *Kz*, calyx-teeth; *n*, five-radiate nectary.

VISITORS.—Knuth observed the following.—

North Frisian Is.—**A. Coleoptera.** 1. Cantharis fusca *L.* (with its head in the flowers). **B. Diptera.** All skg. or po-dvg. (*a*) *Muscidae*: 2. Aricia lardaria *F.*; 3. A. vagans *Fall.*; 4. Lucilia caesar *L.*; 5. Sarcophaga carnaria *L.*; 6. S. sp.; 7. Scatophaga stercoraria *L.*; 8. Trypeta sp.; 9. 4 sps. of smaller Muscidae. (*b*) *Syrphidae*: 10. Eristalis intricarius *L.*; 11. E. tenax *L.*; 12. Helophilus pendulus *L.*; 13. H. trivittatus *F.*; 14. Volucella bombylans *L.* **C. Hymenoptera.** *Apidae*: all skg. or po-cltg.: 15. Apis mellifica *L.*; 16. Bombus agrorum *F.*; 17. B. distinguendus *Mor.*; 18. B. lapidarius *L.*; 19. B. terrester *L.*; 20. Dasypoda plumipes *Pz.*; 21. Panurgus ater *Pz.*; 22. P. lobatus *F.* **D. Lepidoptera.** (*a*) *Rhopalocera*: all skg.: 23. Argynnis aglaja *L.*; 24. Epinephele janira *L.*; 25. Lycaena semiargus *Rott.*; 26. Pieris sp.; 27. Satyrus semele *L.* (*b*) *Sphingidae*: 28. Ino statices *L.*; 29. Zygaena filipendulae *L.* Helgoland.—**A. Diptera.** (*a*) *Muscidae*: 1. Lucilia caesar *L.* (*b*) *Syrphidae*: 2. Eristalis sp.; 3. E. tenax *L.*; 4. Syritta pipiens *L.* **B. Lepidoptera.** *Noctuidae*: 5. Plusia gamma *L.* (Bot. Jaarb. Dodonaea, Ghent, viii, 1896, p. 41).

On May 6, 1897, I observed (Helgoland) the characteristic pollinator of this species, i. e. Andrena carbonaria *L.*, skg. The proportions of the bee exactly correspond to the dimensions of the flowers when the insect inserts its head. Also (occasional), Pieris brassicae *L.* ♂, skg., Lucilia caesar *L.*, do., and Scatophaga sp., do.

The following were recorded by the observers, and for the localities stated.—

Leege (Juist), the Noctuid moth Hydroecia nictitans *L.* Verhoeff in Norderney and Juist (J.).—**A. Coleoptera.** *Scarabaeidae*: 1. Phyllopertha horticola *L.*, po-dvg. (J.). **B. Diptera.** (*a*) *Bibionidae*: 2. Dilophus femoratus *Mg.* ♀, skg.; 3. D. vulgaris *Mg.* ♀ and ♂, skg. (*b*) *Empidae*: 4. Hilara quadrivittata *Mg.* ♀ and ♂, very common, skg. (*c*) *Muscidae*: 5. Aricia incana *Wiedem.* ♀ and ♂, skg.; 6. Cyno-

myia mortuorum *L.* ♂. (*d*) *Syrphidae*: 7. Eristalis intricarius *L.*; 8. Platycheirus sp. ♂, skg. **C. Hymenoptera.** 9. Colletes cunicularius *L.* ♀, po-cltg. (J.). Heinsius (Holland), various flies (Ceratopogon sp. ♀; Dilophus vulgaris *Mg.* ♂; Hilara chorica *Fall.* (?); Rhamphomyia sp. ♀), a short-tongued bee (Prosopis communis *Nyl.* ♂), and a butterfly (Coenonympha pamphilus *L.*) (Bot. Jaarb. Dodonaea, Ghent, iv, 1892, pp. 84–5). Scott-Elliot (Dumfriesshire), a humble-bee, an Empid, a Muscid, a hover-fly, and several Dolichopodids ('Flora of Dumfriesshire,' p. 142).

1791. A. alpina Willd. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 358; MacLeod, Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 373.)—The flower mechanism of this species agrees entirely with that of A. elongata. MacLeod says that crossing and automatic self-pollination are successively ensured. According to Kerner, the stamens of the homogamous flowers are so situated in the first stage of anthesis that insects probing for the abundant nectar are obliged to rub against the pollen-covered anthers, while the five styles with their stigmas are erect in the centre. Anthers and stigmas then change places, the former turning towards the middle of the flower, and the latter moving to its periphery. Should insect-visits fail, the styles ultimately twist up spirally, move back to the centre, and become intertwined with the similarly twisted stamens, so that the stigmas are brought into contact with any pollen that may remain clinging to the latter.

537. Statice Tourn.

Flowers blue-violet in colour, and arranged in conspicuous corymbs; the concealed nectar secreted and stored up in the bases of the flowers. Sometimes heterostyly.

1792. S. Limonium L. (=S. Behen *Drejer*, and S. scanica *Fries*). (MacLeod, Bot. Centralbl., Cassel, xxix, 1887; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 124–5, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 239, 'Bloemenbiol. Bijdragen.')—The plants of this species I examined in the North Frisian Islands were protandrous. The lobes of the corolla, as in Armeria, are held together by the calyx during the first stage of anthesis, and the pollen-covered anthers project 1–2 mm. from them. After these have withered, the styles, which are glabrous at the base, elongate so that the receptive stigmas project from the entrance of the flower. Crossing is therefore ensured by insect-visits, but should these fail, automatic self-pollination is possible by means of the pollen which has fallen out of the anthers and remains in the flowers. Geitonogamy appears to be brought about by the wind, for masses of pollen are not infrequently seen on and near the flowers.

I observed only one type in the North Frisian Islands, but MacLeod describes the following three varieties for the coast of Belgium (near Ter Neuzen and Nieuwport):—

(a) *macrostyla* n. var.: style 7–8 mm. long; stigmatic papillae occupying 2–2½ mm. of the tip of the style, not prominent; stamens short; extine with polygonal markings.

(b) *brachystyla* n. var.: style 4–5 mm. long; stigmatic papillae occupying only ¾–1 mm. of the end of the style, small but more prominent; stamens long; extine without polygonal markings.

(c) *isostyla* n. var.: stamens and style about the same length.

Automatic self-pollination is almost unavoidable in (c); pollen can easily fall from the anthers on the stigma in (b); autogamy sometimes takes place in (a) by bending down of the style.

MacLeod also observed numerous flowers with sterile stamens, so that there is a tendency to gynodioecism.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Amrum), only a few minute Muscids, and a bug (Lygus pratensis *F.*) obviously not adapted to the size and mechanism of the flowers, for a proboscis 5–6 mm. long is required to reach the nectar: (Sylt), the honey-bee, in enormous numbers, skg., the humble-bee Bombus terrester *L.*, do., and the hover-fly Melithreptus nitidicollis *Zett.*, do.: (Langeness in the Hallige), medium-sized Diptera. Willis (neighbourhood of the south coast of Scotland), a beetle (Meligethes sp., podvg.) and a humble-bee (Bombus hortorum *L.*, skg.) ('Fls. and Insects in Gt. Britain,' Part I). Scott-Elliot (Dumfriesshire), a humble-bee and the beetle Meligethes ('Flora of Dumfriesshire,' p. 142).

LXIV. ORDER *PRIMULACEAE* VENT.

Literature.—Herm. Müller, 'Alpenblumen,' pp. 373–4; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 120, 'Grundriss d. Blütenbiol.,' p. 86.

The brightly coloured corolla serves to attract insects. Numerous gradations are found between open nectarless flowers and such as are adapted by the way in which nectar is concealed and their entire mechanism to a restricted circle of long-tongued and industrious insects (bees, Lepidoptera). The flowers belong to the following classes:—**Po**: Trientalis, Lysimachia, Anagallis, Centunculus, Samolus (with pseudonectaries). **C**: Glaux (?), Hottonia, Androsace, Soldanella pusilla *Baumg.*, var. *inclinata* Hb.: Soldanella pusilla *Baumg.*, var. *pendula*, S. alpina. **HbLb**: Primula elatior *Hill*, P. officinalis *Jacq.*, P. vulgaris *Huds.* **Lb**: Primula integrifolia *L.*, P. farinosa *L.*, P. viscosa *All.*, P. longifolia *All.* (diurnal hawk-moth flowers). The species of Hottonia and Primula are usually dimorphous.

538. **Trientalis** Rupp.

Open protogynous pollen flowers, sometimes, according to Schulz, varying to homogamous. The thick fleshy ring which bears the stamens and surrounds the ovary is, however, so juicy that Hermann Müller suggests many visitors may bore it to get the sap.

1793. **T. europaea** L. (Herm. Müller, 'Weit. Beob.,' III, pp. 65–6; Schulz, 'Beiträge,' I, p. 88.)—Hermann Müller says that the white petals of this species spread out into a flat star 12–15 mm. broad. The stamens are directed obliquely upwards and outwards, and their anthers as a rule at first remain closed, while the stigma is at the same level and receptive when the flower opens. The flowers examined by Schulz in the Riesengebirge were either homogamous or very feebly protogynous. The anthers dehisce above and internally, so that an insect when pushing its head into the base of the flower must touch the pollen with one side

of this and the stigma with the other. When several blossoms are visited successively crossing must regularly be brought about.

In the course of anthesis the style elongates to some extent, so that the stigma, at first on the same level as the anthers, ultimately projects beyond them. The flower closes again when it withers, pressing the stamens against the style, so that some pollen can now easily fall on the stigma, or this may come into contact with some of the grains that have dropped on the petals.

The species is represented in the Arctic regions by a variety different in some respects, i. e. *arctica* Fisch.

Visitors.—Herm. Müller only observed the beetle Meligethes.

539. Lysimachia L.

Homogamous yellow pollen flowers.

1794. L. vulgaris L. (Herm. Müller, 'Fertilisation,' pp. 389–90, 'Weit. Beob.,' III, p. 65; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 443–4; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 120–1, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 229–30, 'Bloemenbiol. Bijdragen'; Kirchner, 'Flora v. Stuttgart,' pp. 531–2.)—The golden-yellow flowers of this species exist in three different oecological forms.—

(a) *aprica* Knuth: corolla-lobes about 12 mm. long and 6 mm. broad, golden-yellow in colour with red bases, tips reflexed; filaments red towards their tips; style projecting a few millimetres beyond the two longest stamens, thus ensuring crossing by insect visitors, and rendering automatic self-pollination difficult. Grows in sunny stations on the mainland (but not in the North Frisian Islands).

(*b*) *umbrosa* Knuth: corolla-lobes about 10 mm. long and 6 mm. broad, bright-yellow in colour, directed obliquely upwards, tips not reflexed; filaments greenish-yellow; style as long as the two longer stamens, so that automatic self-pollination is inevitable failing insect-visits. Grows in shady stations.

(c) *intermedia* Knuth: corolla-lobes 10 mm. long and 5 mm. broad, distant, bright-yellow in colour, sometimes reddish at the base; filaments usually reddish; style somewhat longer than the two longest stamens, so that automatic self-pollination takes place more easily than in (a), and with greater difficulty than in (b). Grows in stations of intermediate character, e. g. the sunny edges of ditches. Approximates sometimes to one, sometimes to the other of the well-defined varieties (a) and (b).

Warnstorf describes the pollen-grains as yellow in colour, ellipsoidal, coarsely tuberculate, about 37 μ long and 23 μ broad.

Visitors.—The most important is the bee Macropis labiata *Pz.*, the presence of which in a district appears to be related to that of this species (Ducke also observed at Trieste the rare species Macropis frivaldskyi *Mocs.*). In the North Frisian Islands, which are otherwise rather poor in insects, I found considerable numbers of this bee on the flowers, its hind-legs laden with enormous balls of pollen. In the East Frisian Islands, on the other hand, where this plant is absent, the bee has not been observed, although a pretty complete entomological survey has been made. The same bee has

been seen by me on the flowers in East Holstein, Mecklenburg, Rügen, and Thuringia; by MacLeod in Belgium, Buddeberg in Nassau, Herm. Müller in Westphalia, Krieger at Leipzig, Alfken at Bremen; Friese in Mecklenburg, Baden, Alsace, and Hungary, also at Fiume and Trieste; Nylander in Finland, Morawitz at St. Petersburg, and Delpino in Tuscany ('Ult. oss.,' Atti Soc. ital. sc. nat., Milano, xvi, 1873). Herm. Müller adds that he found the bee in tolerable numbers on flowers growing in sunny stations, the females (which he only saw on this species) industriously brushing off the pollen and heaping it up in thick moistened balls on their hind-legs. How the necessary moisture is obtained is doubtful, but probably the bee bores into the juicy cellular tissues of the flowers. The blades of its maxillae, however, are blunt and clothed with long hairs, so that the function they usually perform may perhaps be carried out by the spines with which the short thick ligula is beset.

The following were recorded by the observers, and for the localities stated.—

Herm. Müller.—**A. Diptera.** *Syrphidae*: 1. Syritta pipiens *L.*, po-dvg. on var. (b), effecting both self- and cross-pollination; 2. Syrphus balteatus *Deg.*, po-dvg. **B. Hymenoptera.** (*a*) *Apidae*: 3. Andrena denticulata *K.* ♂, one, vainly searching for nectar; 4. Halictus zonulus *Sm.* ♂, one, do.; 5. Macropis labiata *Pz.*, var. fulvipes *F.* ♀ (Bavarian Oberpfalz). (*b*) *Vespidae*: 6. Odynerus parietum *L.* ♀, one, po-cltg. and vainly searching for nectar. Knuth (Rügen), the fossorial wasp Crabro palmarius *Schreb.* Alfken (Bremen), the bees Halictus calceatus *Scop.*, and H. morio *F.* Friese for Fiume (F.) and Trieste (T.), 2 bees—1. Andrena korleviciana *Friese* (F., T.), not rare (Korlevič); 2. Macropis frivaldskyi *Mocs.* (Hungary), occasional (F.), freq. (Korlevič).

1795. L. nemorum L. (Kirchner, 'Flora v. Stuttgart,' p. 532; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 444; Knuth, 'Bloemenbiol. Bijdragen.')—In the egg-yellow flowers of this species the diverging stamens are of equal length, and remote from the stigma, which is situated at a somewhat lower level. Kerner states, however, that automatic self-pollination takes place by contact of anthers and stigma.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth, the po-dvg. hover-fly Syrphus balteatus *Deg.* Scott-Elliot (Dumfriesshire), a Muscid and several Dolichopodids ('Flora of Dumfriesshire,' p. 115).

1796. L. Nummularia L. (Darwin, 'Variation,' II, p. 154; Kirchner, 'Flora v. Stuttgart,' p. 532; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 444; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Knuth, 'Bloemenbiol. Bijdragen.')—The large golden-yellow flowers of this species are marked internally with glandular brown points. Their stamens are of unequal length. Although owing to the size of the flowers crossing by insect visitors appears to take place pretty frequently, automatic self-pollination can also be easily effected, as was pointed out by Darwin, though this rarely results in the formation of seeds. Warming suggests that this is because all the plants of a particular station have been derived from the same original stock. Warnstorf states that the flowers are protogynous at Ruppin. At the time when the pollen is ripe the anthers are usually at the same level as the stigma, so that autogamy is inevitable. The pollen-grains are yellow in colour, very irregular

(ellipsoidal, or ovoid to tetrahedral), beset with a network of papillae, variable in size (25–30 μ in diameter).

Visitors.—I observed the honey-bee, po-cltg.

1797. L. thyrsifolia L. (Warming, Bot. Tids., Kjöbenhavn, ii, 1877; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 326; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The flowers of this species are protogynous. The ovary is covered with small papillae, which Kerner says serve as food to visitors. Warnstorff states that the receptive stigma projects from the flowers before they open. After they have done so, the stamens become erect and are remote from the stigma, sometimes attaining the same level and sometimes being a little shorter. The pollen-grains are yellow in colour, ellipsoidal, finely tuberculate, up to 31 μ long and 19 μ broad. Kerner states that geitonogamy takes place should insect-visits fail, for the filaments elongate and bend in such a way as to transfer the pollen to the stigmas of adjacent flowers.

Visitors.—I saw the po-dvg. hover-fly Syritta pipiens *L.*

1798. L. ciliata L. (=Steironema ciliatum *Rafin.*).—Kerner says that in this species also there are little papillae on the ovary which are devoured by insect visitors.

540. Anagallis L.

Homogamous pollen flowers.

1799. A. arvensis L. (=A. phoenicea *Scop.*). (Delpino, 'Alc. app.'; Herm. Müller, 'Fertilisation,' pp. 390–2; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 217;

Fig. 236. *Anagallis arvensis, L.*; and *A. caerulea, Schreb.* (after Herm. Müller). (1) Fully open flower of *A. arvensis*. (2) Half-open flower of do. (3) Fully open flower of *A. caerulea*. (4) Do., seen from the side, after removal of part of the calyx and corolla. *a*, anthers; *p*, petals; *s*, sepals; *st*, stigma.

MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 442–3; Kirchner, 'Flora v. Stuttgart,' p. 535; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 121.)—The red flowers of this species expand in sunny weather from 9 (7) a.m. to 3 (2) p.m., to form a disk 10–12 mm. in diameter. The anthers of the five diverging stamens are covered with pollen all round, and the style bends down between them in such a way that the simultaneously mature stigma must first be touched by an insect visitor alighting on the lower part of the corolla. Crossing will thus be effected if the visitor is already dusted with pollen.

The corolla closes in the afternoon, bringing the stigma into contact with the

anthers of the three lowest stamens, so that automatic self-pollination regularly takes place, and this is largely made use of by the plant, for scarcely any insect visitors have so far been observed.

Kerner states that each flower opens and closes three times, after which it does not open again. During the periodic closing of the corolla, the pollen which clings to it is brought into contact with the stigma and autogamy consequently effected. During unfavourable weather the flowers remain closed and self-pollination takes place pseudo-cleistogamously. (*Cf.* Fig. 236.)

It is possible that the delicate clavate hairs covering the filaments may be used by visitors as food, in addition to the pollen.

Visitors.—Smith (England) saw the bee Halictus morio *F.*

1800. A. caerulea Lam. (=A. arvensis *L.*, according to the *Index Kewensis*). (Herm. Müller, loc. cit.)—The flower mechanism of this species is exactly the same as that of A. arvensis. It must, however, be regarded as a distinct species, for Clos states that when crossed with the latter no seeds capable of germination are produced.

1801. A. tenella L.—The plants of this species observed by MacLeod on the dunes of Flanders bore white or reddish pollen flowers, with red-violet longitudinal streaks on the corolla-lobes. The corolla-tube is deeper than in the two last species, and is quite filled up by the hairs covering the filaments. The stigma projects 2–3 mm. beyond the anthers, so that automatic self-pollination cannot take place.

541. Centunculus Dill.

Inconspicuous homogamous pollen flowers.

1802. C. minimus L. (Ascherson, Bot. Ztg., Leipzig, xxix, 1871, p. 553; Herm. Müller, 'Fertilisation,' p. 390; Kirchner, 'Flora v. Stuttgart,' p. 535; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 170, 213, 332; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 121, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 230.)—In this species the very small white or reddish flowers are regularly self-pollinated, for in unfavourable weather they remain closed and pseudo-cleistogamy obtains. Crossing is now and then possible, however, for Kerner says that the flowers open for a short time in bright sunshine between 10 and 11 a.m.

In the island of Föhr I noticed numerous purely cleistogamous flowers.

542. Androsace L.

Literature.—Herm. Müller, 'Alpenblumen,' pp. 357–8.

Homogamous (also protogynous according to Kerner) flowers, with concealed nectar secreted in favourable weather only by the surface of the ovary and hidden in the shallow ($1\frac{1}{2}$–2 mm.) corolla-tube. This narrows above, leaving only a very small aperture, so that although the nectar is not deeply concealed, it can only be found by the more intelligent insects, an orange-coloured nectar-guide indicating its position. When Lepidoptera, bees, or the more skilful flies insert their proboscis into the narrow opening of the flower, one side of this touches the stigma and the other side the anthers, so that crossing is ensured. Should insect-visits fail, self-pollination is secured by the nearness of the anthers to the stigma in the homogamous flowers.

The narrowness of the corolla-tube protects the nectar from rain-drops, which are unable to displace the air.

Kerner states that many species are heterostylous.

1803. A. septentrionalis L. (Herm. Müller, 'Alpenblumen,' p. 358; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 341.)—The white flowers of this species are only 6 mm. in diameter. (*Cf.* Fig. 237.) Kerner says that automatic self-pollination is ultimately effected by contact of the anthers and stigma.

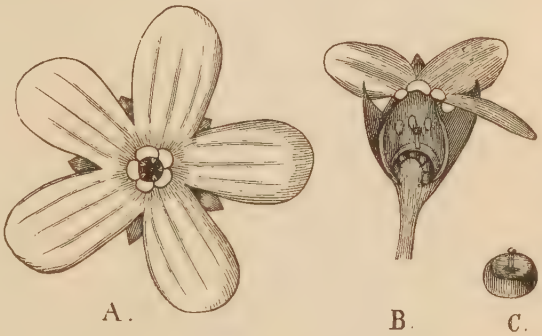


FIG. 237. *Androsace septentrionalis*, *L.* (after Herm. Müller). *A.* Flower seen directly from above. *B.* Do. in longitudinal section. *C.* Pistil seen obliquely from above (× 7).

VISITORS.—Herm. Müller observed an Empid, a Syrphid, and 3 Muscids.

1804. A. Chamaejasme Willd. (Herm. Müller, 'Alpenblumen,' pp. 358–9.)—In this species the flowers are 7–8 mm. in diameter. The nectar-guide is at first yellow in colour, but becomes carmine-red after pollination has been effected. Should insect-visits fail, the latter takes place automatically by the fall of pollen. (*Cf.* Fig. 238.)

VISITORS.—Herm. Müller observed 15 flies, 4 Lepidoptera, and a bee.

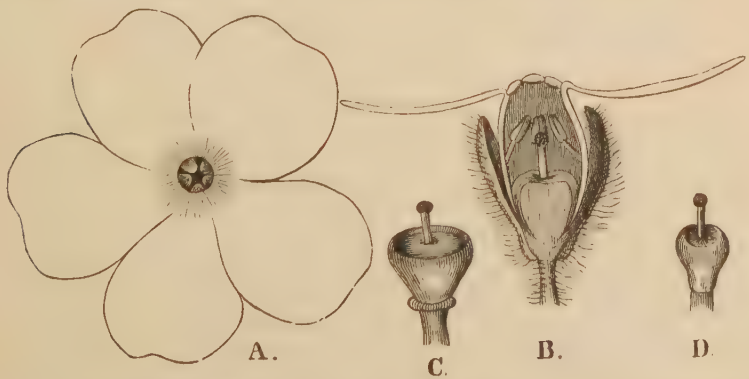


FIG. 238. *Androsace Chamaejasme*, *Willd.* (after Herm. Müller). *A.* Flower seen directly from above. *B.* Do. in longitudinal section. *C.* Older pistil seen obliquely from above (× 7). *D.* Younger pistil.

1805. A. obtusifolia All. (Herm. Müller, 'Alpenblumen,' p. 360.)—The white flowers of this species are more than 8 mm. in diameter. Autogamy is easily effected.

VISITORS.—Herm. Müller observed 10 flies and 3 Lepidoptera.

1806. A. alpina Lam. (=A. glacialis *Hoppe*). (Herm. Müller, 'Alpenblumen,' p. 360.)—The white or rose-red flowers of this species are 5 mm. broad, and possess nectar-guides. They are homogamous, and autogamy takes place should insect-visits fail.

1807. A. bryoides DC. (=A. helvetica *All.*); **1808. A. imbricata** Lam.; and **1809. A. alpina** Lam. (=A. pubescens *DC.*). (Herm. Müller, loc. cit.)—These species are homogamous, and self-pollination takes place should insect-visits fail.

1810. A. lactea L. (Briquet, 'Études de biol. flor. dans les Alpes occident.')—Briquet states that the flowers of this species are white with a yellow throat. The limb of the corolla is 11–12 mm. in diameter, while the corolla-tube is 2 mm. broad with an entrance of ½ mm. As the flowers are homogamous, and the five anthers almost touch the capitate stigma and project beyond it, automatic self-pollination regularly takes place, and this is also effected by Diptera and small Lepidoptera. Briquet was unable to confirm the statement of Kerner that nectar is secreted on the upper surface of the ovary. Kirchner, however, found little drops of nectar on the flat upper side of the ovary, both in this species and also in A. villosa, while Kerner made similar observations for the species of Androsace in general. The flowers of A. lactea possess an agreeable odour.

1811. A. villosa L. (Briquet, op. cit.)—Briquet says that the flowers of this species agree with those of A. lactea, except that the corolla is somewhat larger, and its throat at first flesh-coloured and afterwards white. He observed no visitors. In flowers examined by Kirchner the diameter was only 8–9 mm., and the throat of the corolla golden-yellow at the beginning of anthesis, afterwards changing to a peach-blossom red. MacLeod ('Pyreneënbl.,' p. 372) describes the flowers as white or rose in colour, with purple or yellowish nectar-guides, and a somewhat ventricose corolla-tube 3–3½ mm. long and constricted at the throat.

Visitors.—MacLeod observed 3 flies and a Lepidopterid.

1812. A. Vitaliana Lap. (=Douglasia Vitaliana).—Treviranus describes this species as dimorphous (Bot. Ztg., Leipzig, xxi, 1863, p. 6).

543. Primula L.

Literature.—Charles Darwin, J. Linn. Soc. Bot., London, vi, 1862, pp. 77–96; Treviranus, Bot. Ztg., Leipzig, xxi, 1863; Hildebrand, op. cit., xxii, 1864; Scott, J. Linn. Soc. Bot., London, viii, 1865; Pax, 'Primulaceae,' in Engler and Prantl, 'D. nat. Pflanzenfam.,' IV, 1.

Flowers mostly homogamous and heterostylous-dimorphous, sometimes homostylous; rarely protandrous and belonging to classes **L** or **Hh** (or **Hb**); sometimes belonging to both **Hh** and **L**. Nectar is secreted by the base of the ovary, and sheltered in the corolla-tube. The pollen-grains of the long stamens are larger than those of the short ones, and the stigmatic papillae of the long styles are longer than those of the short styles.

Darwin's researches showed that 'legitimate' pollination, in which the stigma of the long (or short) style receives pollen produced at the same level by the anthers of the long (or short) stamens, results in a much higher degree of fertility than 'illegitimate' pollination. (*Cf.* Vol. I, pp. 47–8.)

He also found Primula officinalis, P. sinensis, and P. Auricula very infertile when insect-visits were prevented, but completely fertile when such visits were permitted or artificial pollination effected. Legitimate unions were about 1½ times as fertile as illegitimate ones.

These results were confirmed by the investigations of Hildebrand, who further proved that when flowers were artificially self-pollinated fertility was at a minimum. By sowing separately the seeds resulting from the different kinds of union, Hildebrand found that when both parents were long-styled the offspring were predominatingly so, and similarly for short-styled stocks. Crosses between the two kinds of stock resulted in offspring which were long- and short-styled in approximately equal proportions.

The researches of Darwin and Hildebrand threw entirely new light on the significance of crossing and sexuality in general.

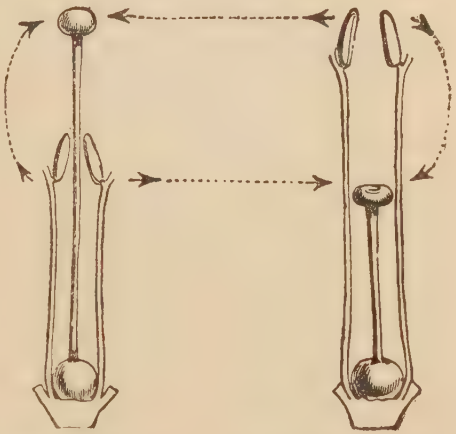


FIG. 239. *Diagram of the Legitimate and Illegitimate Unions possible in Primula* (after Charles Darwin). The legitimate unions are indicated by horizontal dotted lines, and the illegitimate ones by curved ditto.

1813. P. elatior Hill. (Herm. Müller, 'Fertilisation,' pp. 384–5, 'Alpenblumen,' p. 369, 'Weit. Beob.,' III, pp. 64–5; Schulz, 'Beiträge,' II, pp. 145–6; Kirchner, 'Flora v. Stuttgart,' pp. 533–4; Knuth, 'Bloemenbiol. Bijdragen'; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 444–6.)—This species bears heterostylous flowers belonging to class **HhL**, which do not attain their full size till towards the end of anthesis. The corolla is of pale-yellow colour with a yolk-yellow throat, and its tube differs in length and shape in the long- and short-styled forms.

(a) *brachystyla*: corolla-tube 15–17 mm. long, gradually narrowing to a little distance (3–5 mm.) below the horizontally expanded limb, and then at a level of 12–13 mm. from its base enlarging again. The five anthers, borne on filaments with wider bases, are situated in this enlarged region, and they extend to the opening of the tube, where their tips converge. The pollen-grains are about twice as large as in (b). The relatively thick style is about half the length of the corolla-tube; the stigma is broader than deep, and beset with short papillae.

(b) *macrostyla*: corolla-tube 12–14 mm. long, widening somewhat in the middle where the stamens are inserted, and then gradually narrowing again. The pollen-grains are only about half as large as in (a). The style is tolerably thin in its upper part, and so long that the spheroidal stigma is situated in the entrance of the flower. The stigmatic papillae are about five times as long as those of (a).

The two kinds of flowers are about equally frequent, and borne on separate stocks.

Humble-bees probing for nectar in the legitimate way touch the organs in the entrance of the flower with their heads, and those in the middle of the corolla-tube with their laciniae. The regions in question consequently get dusted with pollen, which is transferred to stigmas situated at the same level in the other kinds of stock,

so that 'legitimate' union is regularly effected. As the head of a humble-bee, about 5 mm. in length, can be entirely thrust into the corolla-tube of either sort of flower, a proboscis 12 mm. long is able to probe the longest tubes, while one not less than 7 mm. can suck all the nectar from flowers with the shortest tubes.

Legitimate crossing is regularly effected, not only by humble-bees, but also by the brimstone butterfly (Rhodocera rhamni *L.*). The first observation regarding it was made by A. Mülberger, of which Hermann Müller says: 'In my Black Forest valley (Herrenalb) Primula elatior is the first, and for a long time the only hunting-ground, where it can disport itself. It visits the long- and short-styled forms apparently without discrimination. The flower and the butterfly are usually of precisely the same yellow colour. In a short-styled flower it is generally easy to see if it has or has not been visited by a butterfly. In the former case a small hole formed by the proboscis is seen between the anthers which exactly fill the mouth of the corolla-tube.' Müller has seen this butterfly as a visitor at Lippstadt and at Kiel (21. 3.'96). I have noticed it flying industriously from flower to flower. The mark left by the inserted proboscis is always easily detected. As an equally frequent visitor I saw Bombus hortorum *L.* ♀. Both the insects visited with equal zeal the three associated species (P. elatior, P. officinalis, P. vulgaris), so that they effected hybridization as well as crossing.

Flowers which have been perforated by humble-bees (Bombus terrester *L.*) just above the calyx are not infrequently to be seen.

Visitors.—*Vide supra.* Herm. Müller observed a humble-bee and a hover-fly in the Alps, and gives the following list for Lippstadt.—

A. Coleoptera. *Staphylinidae*: 1. Omalium florale *Payk.*, freq., creeping about in the flowers. **B. Diptera.** *Bombyliidae*: 2. Bombylius discolor *Mg.*, freq., skg.; 3. B. major *L.*, much rarer, not as a rule getting at the nectar. **C. Hymenoptera.** *Apidae*: 4. Andrena gwynana *K.* ♀, freq., po-cltg. on the short-styled flowers, but leaving the long-styled ones at once; 5. Anthophora pilipes *F.* ♀ and ♂, very numerous, skg. legitimately and po-cltg.; 6. Apis mellifica *L.* ☿, casually skg.; 7. Bombus confusus *Schenck* ♀, skg. legitimately; 8. B. hortorum *L.* ♀ and ☿, very numerous, skg. legitimately, and po-cltg.; 9. B. lapidarius *L.* ♀, skg. legitimately; 10. B. sylvarum *L.* ♀, do.; 11. B. terrester *L.*, perforating the corolla-tubes and stealing nectar; 12. Osmia rufa *L.* ♂, casually skg.

The following were recorded by the observers, and for the localities stated.—

MacLeod (Belgium), 2 long-tongued bees, skg. legitimately (Anthophora pilipes *F.*, and Bombus hortorum *L.*), a short-tongued bee (Andrena gwynana *K.* ♀, po-cltg.), and the honey-bee, skg. for a short time; also the humble-bee Bombus terrester *L.*, perforating the flowers. Alfken (Bremen), 6 bees—1. Andrena cineraria *L.* ♀; 2. Bombus agrorum *F.* ♀; 3. B. hortorum *L.* ♀; 4. B. pratorum *L.* ♀; 5. Osmia rufa *L.* ♂; 6. Podalirius acervorum *L.* ♂.

1814. **P. officinalis** Jacq. (=P. veris, var. *officinalis*). (Darwin, 'Forms of Flowers,' p. 14; Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.,' p. 34; Herm. Müller, 'Fertilisation,' p. 385, 'Weit. Beob.,' III, p. 65; Kirchner, 'Flora v. Stuttgart,' p. 534, 'Beiträge,' p. 51; Schulz, 'Beiträge,' II, pp. 141–2; Ljungström, 'Eine Primula-Exkursion nach Möen'; Loew, 'Blütenbiol. Floristik,' p. 392; Knuth. 'Bloemenbiol. Bijdragen'; Weiss, New Phytol., London, iii, 1904, p. 168.)—This species bears heterostylous flowers belonging to class **HhL**. Their mechanism is the same as

that of P. elatior and they are yellow in colour, usually with an orange-red patch in the throat that serves as a nectar-guide. Flowers devoid of this patch have, however, been observed by Kirchner in Wurtemburg and Appel (as he tells me in a letter) at Würzburg. Schulz has measured the flowers and finds that they do not attain their full size till towards the end of anthesis. In long-styled flowers the style usually elongates during this process of growth, but sometimes its development is arrested, so that the anthers and stigma are ultimately at the same level. Breitenbach and Schulz noticed such equal-styled (isostylous) flowers. The latter states that the short-styled form is somewhat smaller than the long-styled one, and that its style is always of approximately the same length. Kirchner noticed large- and small-flowered forms in Wurtemberg.

In the island of Möen E. Ljungström observed two forms in which the calyx was markedly short or long, respectively, as compared with the corolla-tube, and he gave them the varietal names of *brevicalyx* and *longicalyx*. He also found variations as regards the breadth of the limb of the corolla, and distinguished between two forms, *latiloba* and *angustiloba*, respectively possessing a broad and a narrow limb. In flowers with a short calyx the corolla was often very large, elegantly saucer-shaped, and of a beautiful yellow colour. On the other hand, a long calyx was not infrequently associated with a smaller and paler corolla.

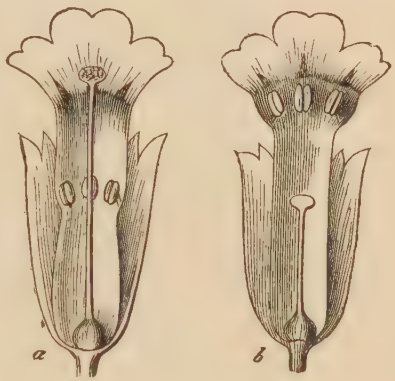


FIG. 240. *Primula officinalis*, *Jacq.* (after Hildebrand). (*a*) Long-styled and (*b*) short-styled flowers, partly dissected from the side.

The corolla-tube is fairly often perforated by humble-bees.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller.—**A. Coleoptera.** *Nitidulidae*: 1. Meligethes, po-dvg. **B. Diptera.** *Bombyliidae*: 2. Bombylius discolor *Mg.*, skg. **C. Hymenoptera.** 3. Andrena gwynana *K.* ♀, in large numbers, po-cltg. on short-styled flowers, but leaving long-styled ones after a brief visit; 4. Anthophora pilipes *F.* ♀ and ♂, freq., skg.; 5. Bombus agrorum *F.* ♀, skg.; 6. Halictus albipes *F.* ♀, as 3; 7. H. cylindricus *F.* ♀, do. Knuth, the butterfly Rhodocera rhamni *L.*, and the humble-bee Bombus hortorum *L.* (*cf.* P. elatior). Loew (Brandenburg), the humble-bee Bombus hortorum *L.*, skg. ('Beiträge,' p. 45); (Berlin Botanic Garden), the bee Anthophora pilipes *F.*, skg., on the var. *colorata*. MacLeod (Pyrenees), the humble-bee Bombus majellus *K.* (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 372). F. E. Weiss (England), humble-bees—Bombus muscorum *F.*, and B. terrester *L.*

1815. P. vulgaris Huds. (=P. acaulis *Hill*). (Darwin, 'Forms of Flowers,' p. 34–5, 37, 266; Lange, Bot. Tids., Kjöbenhavn, xiv, 1885, pp. 147–58; Correns, Ber. D. bot. Ges., Berlin, vii, 1889, pp. 265–72; Focke, Abh. natw. Ver., Bremen, ix, 1887, pp. 75–6; Cobelli, Abh. Zool. Bot. Ges., Wien, xliii, 1892, pp. 73–8; Ljungström, 'Eine Primula-Exkursion nach Möen'; Knuth, Bot. Centralbl., Cassel, lv, 1893,

pp. 225–7; lxiii, 1895, pp. 97–8; F. E. Weiss, New Phytol., London, ii, 1903, p. 99, iii, 1904, p. 168.)—This species bears heterostylous flowers belonging to class **HhL**. Those examined by me in Schleswig-Holstein were of sulphur-yellow colour, with a

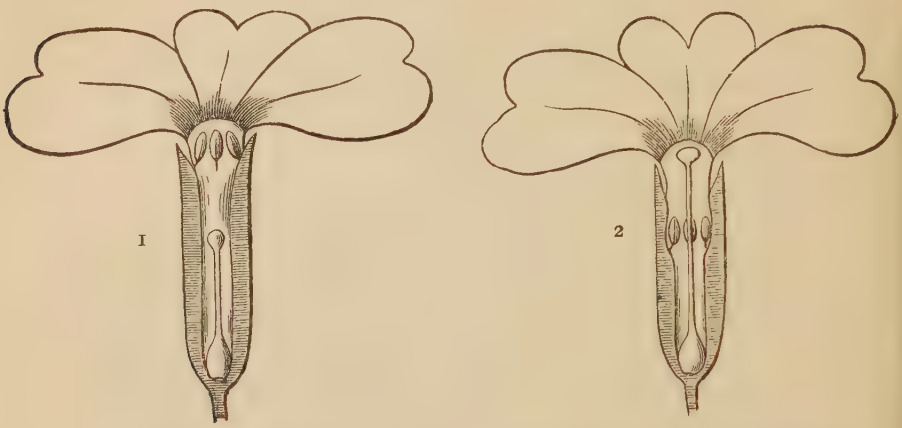


FIG. 241. *Primula vulgaris*, *Huds.* (1) and (2) Short- and long-styled flowers, in longitudinal section (× 2).

Relative size of the pollen-grains (3) of the short-styled, and (4) of the long-styled flower.

Relative size of the stigmatic papillae (5) of the long-styled, and (6) of the short-styled flower.

darker nectar-guide at the base of each corolla-lobe. Their diameter varied from $2\frac{1}{2}$ to 4 cm., but was usually about 3 cm. Similarly the length of the corolla-tube was $1\frac{1}{2}$–$2\frac{1}{2}$ cm., mostly, however, about 2 cm.

In the long-styled form the stigma is situated in the opening of the flower, while the anthers are inserted into the corolla-tube about its middle. In the short-styled form the opening of the corolla-tube, which widens somewhat like a funnel, is, of course, occupied by the five anthers, while the style with its stigma is about half as long as the tube. There are microscopic differences between the two forms as regards the length of the anthers and the shape of the stigma. In short-styled flowers the anthers are generally rather more than 2 mm. long, in long-styled ones usually a little less. The stigma in the latter is spheroidal as a rule with a diameter of 1·1 mm., but in short-styled flowers it is mostly somewhat flattened, about 1·2 mm. broad and 0·9 mm. deep. With the aid of a lens the stigmatic papillae of the long-styled form are clearly visible, but those of the short-styled one scarcely perceptible. The former are 0·07 mm. long and 0·01 mm. broad, the latter 0·02 mm. long and about the same in breadth. The pollen-grains are of an angular ovoid shape, those of the long-styled form 0·025 mm. long and 0·02 mm. broad, and those of the short-styled one almost 0·04 mm. long and 0·025 mm. broad.

As in the case of the last species, Ljungström observed four varieties in the island of Möen, i. e. *brevicalyx*, *longicalyx*, *latiloba*, and *angustiloba*. He also noticed a form (*lactea*) with an almost milk-white corolla, and another (*colorata*)

in which this was purple-violet, except for its star-shaped yellow centre and sometimes whitish margin.

Visitors.—I saw at Kiel (25. 4.'95) several individuals of Bombus hortorum *L.* ♀, flying busily from flower to flower, and sinking their proboscis into the corolla-tube, so that in long-styled flowers the laciniae, and in short-styled ones the head became dusted with pollen. This was then transferred to stigmas at corresponding levels, and legitimate crossing regularly effected. These humble-bees, however, not only visited this species, but also P. officinalis and P. elatior, which were growing near, so that a great deal of hybridization as well as crossing must have been brought about. In some cases the bee Anthophora pilipes *F.* ♀ behaved in the same way as Bombus hortorum, though it preferred the flowers of Pulmonaria officinalis, which grew close by.

In the two last-named insects the proboscis is 18–21 mm. long, so that it can easily reach the nectar concealed in the bases of the flowers of this and the last two species. The average length of the corolla-tube is here 20 mm., but in P. officinalis and P. elatior it is considerably shorter. As a bee when sucking can completely thrust its head (about 5 mm. long) into the opening of the corolla-tube, it follows that other species with shorter tongues are able to legitimately pollinate P. officinalis and P. elatior. Hermann Müller actually observed humble-bees of the kind doing this.

The three species of Primula in question can also be pollinated by the brimstone butterfly (Rhodocera rhamni *L.*). Cobelli saw it on P. vulgaris, Mülberger and Hermann Müller on P. elatior, and myself on all three (26. 4.'96).

Cobelli also observed Bombylius medius *L.* on P. vulgaris, and the other two species of Primula are also visited by Bombyliids, though only those with a particularly long proboscis are able to get at the nectar.

On March 21, 1896, I saw Vanessa urticae *L.* flying persistently from flower to flower of this species (eighteen were successively visited). This butterfly sucked very vigorously, and evidently succeeded in getting a part of the nectar. Though useless to the short-styled flowers, it undoubtedly transferred their pollen to the stigmas of long-styled ones. I also saw the honey-bee visit several flowers in succession, and as it sucked with equal zeal it perhaps succeeded in reaching the uppermost layer of nectar.

Wüstnei noticed the bee Anthophora acervorum *L.* in the island of Alsen, and Cobelli saw small beetles, though these could only effect crossing by accident.

We may say of Primula vulgaris, P. elatior, and P. officinalis, that all three are chiefly pollinated by long-tongued Hymenoptera and the brimstone butterfly, while Bombyliids, Vanessa urticae, and the honey-bee are visitors of secondary importance.

I was able to observe directly the transfer of pollen by visitors for the short distance of a few metres, but Focke has seen a hybrid between P. vulgaris and P. officinalis, for the development of which it must have been carried a kilometre.

Gibson ('Flora of St. Kilda') states that in St. Kilda, the most westerly island of Scotland (except the barren Rockall), where bees, wasps, and Lepidoptera are absent, the primrose appears to be pollinated by flies, for fruits are now and then set.

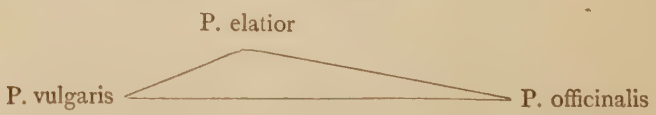
Archer Briggs (Rep. Inst., Plymouth, iv, 1871–2) did not notice the larger humble-bees in England, but only Anthophora acervorum *L.*, freq., smaller bees

(Andrena gwynana *K.*), the brimstone butterfly (Rhodocera rhamni *L.*), and a Bombyliid (Bombylius medius *L.*, freq.).

The following were recorded by the observers, and for the localities stated.—

Burkill (Yorkshire coast) ('Fertlsn. of Spring Fls.').—**A. Coleoptera.** 1. Anthobium (Eusphalerum) primulae *Fauv.* (=A. triviale *Er.*), dvg. the anthers; 2. Meligethes picipes *Sturm.*, skg. **B. Hymenoptera.** *Apidae*: 3. Andrena gwynana *K.* ♀, searching for nectar, but unable to reach it. **C. Thysanoptera.** 4. Thrips sp., freq. Burkill elsewhere remarks that 'the fertilization of this plant is yet unexplained. None of the insects seen on it through many hours of watching are sufficient for its fertilization.' Darwin, only Thrips: he says 'the primrose is never visited (and I speak after many years' observation) by the larger humble-bees and rarely by the smaller kinds.' Scott-Elliot (Dumfriesshire), the humble-bee Bombus hortorum *L.* Miller-Christy (Essex), 2 bees (Apis mellifica *L.*, and Anthophora acervorum *L.*), humble-bees (Bombus sp.), a hover-fly (Syrphus sp.), 2 butterflies (Rhodocera rhamni *L.*, and Pieris rapi *L.*), and a beetle (Meligethes picipes *Sturm.*). Loew (Berlin Botanic Garden), the bee Anthophora pilipes *F.*, steadily skg. and po-cltg., and settling repeatedly. E. Bell (England) only noticed 4 visitors 'after seeing and examining thousands and thousands, we might say millions of the flowers': he adds that 'the primrose gives unimpeachable evidence that self-fertilization of heterostyled plants is the natural and legitimate fertilization as being fully productive' ('The Primrose and Darwinism'). F. E. Weiss (Shropshire), the Bombyliid Bombylius major *L.*, freq. (also in North Staffordshire), the humble-bee Bombus terrester *L.*, and 3 bees—1. Andrena gwynana *K.*, freq.; 2. Anthophora pilipes *F.*; 3. Apis mellifica *L.* Miss M. L. Armitt (Westmoreland, *teste* Weiss), Bombylius, effecting crossing. Weiss endeavours to reconcile conflicting views: 'The fact that many observers have been unable to detect such insect visitors I attributed to their observations having been made either in cold or dull weather, or in exposed and windy situations. For even on sunny days I could not observe the usual insect visitors on primroses in wind-swept localities, while, at the same time, in sheltered positions some larger humble-bees might occasionally be met with on the primroses, and *Anthophora*, *Bombylius*, and pollen-gathering Andrenae fairly regularly.' He finally concludes: 'From the observations I have made on the primrose, I feel convinced that it is both regularly visited and cross-pollinated by insects under favourable climatic conditions, but that like most flowers adapted to the visits of insects, it is provided with efficient means for self-pollination, and these are important to a plant flowering at so early a period of the year when the visits of insects may be precarious.'

Ljungström graphically represents the relationship between the three species of Primula just considered by means of a scalene triangle, of which the angles represent the species, and in which the shortest side is between P. vulgaris and P. elatior, and the longest between P. vulgaris and P. officinalis.



This diagram also indicates the degree of fertility of the hybrids, for the (pollen) sterility of these increases as the affinity of the stocks crossed becomes more remote. Ljungström examined the pollen of various hybrids and obtained the following results.—

P. vulgaris × P. officinalis: 26·5–33 % normal pollen-grains, 73·5–67 % shrivelled and useless.

P. elatior × P. officinalis: 31–6 % good, 69–63 % shrivelled and useless.

P. elatior (average of flowers from Schonen): 33 % normal, 67 % shrivelled and useless.

P. elatior × P. per-officinalis (from Schonen): 45 % normal, the rest shrivelled and useless.

P. vulgaris × P. elatior: 66–9 % normal.

P. vulgaris (per-acaulis) × P. elatior: 78 % normal.

These results appear to be confirmed by the number of seeds developed in the different cases.

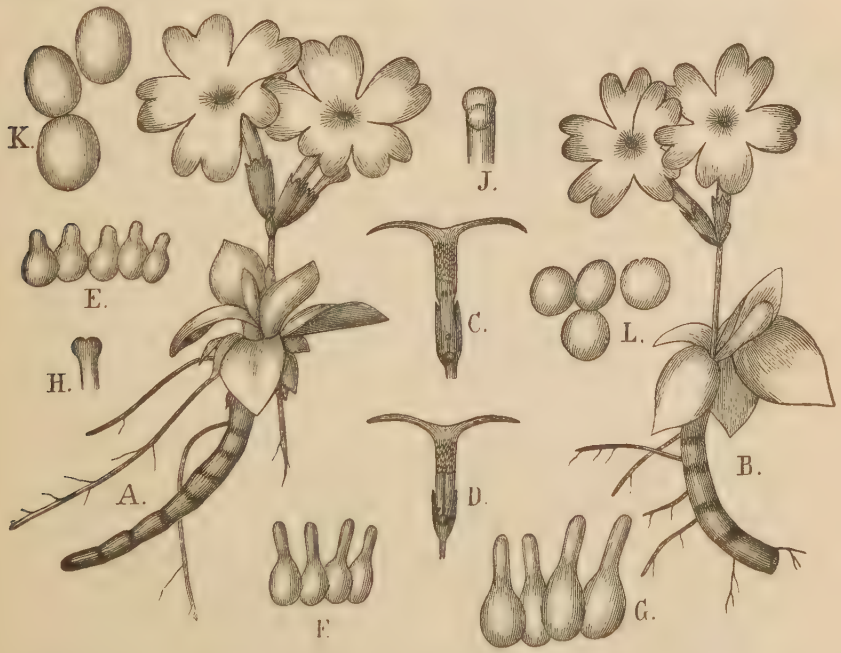


FIG. 242. *Primula integrifolia*, *L.* (after Herm. Müller). *A*, *B*. Short- and long-styled plants (natural size). *C*, *D*. Short- and long-styled flowers, partly dissected (natural size). *E*. Stigmatic papillae of the short-styled, *F*, *G*, do. of the long-styled flowers. *H*, *J*. Stigmas of the short- and long-styled flowers (× 7). *K*, *L*. Moistened pollen-grains of short- and long-styled flowers.

1816. P. integrifolia L. (Herm. Müller, 'Alpenblumen,' pp. 350–62.)—This species bears dimorphous heterostylous butterfly flowers. The tube of the purple-red corolla is 10–14 mm. long, and as a rule is of noticeably greater length in the short-styled form, where also the limb of the corolla is broader. (*Cf.* Fig. 242.)

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 7 Lepidoptera, a Bombyliid, and a beetle. Redtenbacher (Austria), the Staphylinid beetle Anthobium robustum *Heer*.

1817. P. villosa Jacq. (?) (Herm. Müller, 'Alpenblumen,' pp. 362–3.)—This species bears dimorphous heterostylous butterfly flowers. According to Pax (Bot. Jahrb., Leipzig, x, 1888, p. 227), the species described by Hermann Müller as

P. villosa *Jacq.* is apparently P. hirsuta *All.*, for the former is only to be found in Steiermark. Gremli ('Exkursionsflora für die Schweiz,' 6. Aufl., 1889, p. 359) says that P. hirsuta *All.* is identical with P. viscosa *Vill.*, but not with P. villosa *Koch*, nor with P. villosa *Jacq.* [P. villosa *Jacq.* = P. villosa *Wulf.*, according to the *Index Kewensis.*]

FIG. 243. *Primula villosa*, *Jacq.* (?) (after Herm. Müller). *A*, *B*. Short- and long-styled flowers, seen from the side (natural size). *C*, *D*. Do., seen from above. *E*, *F*. Do. in longitudinal section.

The flowers are of a dark violet-red colour, with a tube 10–13 mm. long, but hardly 1½ mm. wide, so that only Lepidoptera can get at the nectar. (*Cf.* Fig. 243.)

VISITORS.—Herm. Müller observed 3 butterflies; also a beetle as an unbidden guest.

1818. P. viscosa All. (=P. latifolia *Koch*, and P. graveolens *Heg.*). (Herm. Müller, 'Alpenblumen,' pp. 367–9.)—This species bears dimorphous heterostylous butterfly flowers. The corolla-tube is so narrow, that between it and the stigma the distance is scarcely ½ mm., and consequently the

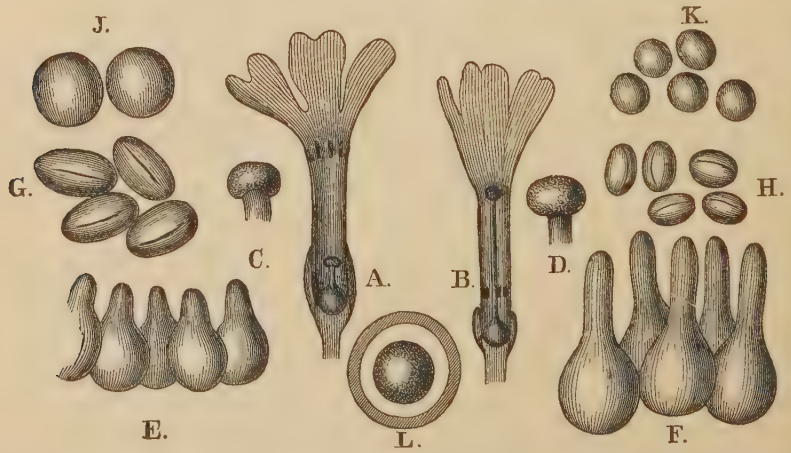


FIG. 244. *Primula viscosa*, *L.* (after Herm. Müller). *A*, *B*. Short- and long-styled flowers, partly dissected (× 2). *C*, *D*. Stigmas of do. (× 7). *E*, *F*. Stigmatic papillae of do. *G*, *H*. Dry pollen-grains of do. *J*, *K*. The same, moistened. *L*. Cross-section of a long-styled flower just above the stigma (× 7).

nectar can only legitimately be sucked by the proboscis of a lepidopterous insect, which must at the same time touch the anthers and stigma. The requisite length of proboscis is 12–14 mm. (*Cf.* Fig. 244.)

VISITORS.—Herm. Müller only observed useless (Rhingia campestris *Mg.*) and injurious (Bombus mastrucatus *Gerst.*, stealing nectar) guests.

1819. P. farinosa L. (Darwin, 'Forms of Flowers,' pp. 45, 224, 273; Herm. Müller, 'Alpenblumen,' pp. 363–7; MacLeod, 'Pyreneënbl.,' p. 372.)—This species bears dimorphous heterostylous butterfly or humble-bee flowers. It is of particular interest because in the Alps, where Lepidoptera abound, it is adapted to butterflies, while in North Pomerania, where Lepidoptera are relatively few and bees abundant, it is adapted to the latter. Herm. Müller gives the following differences between flowers from the two regions.—(1) Alpine plants bear flowers which are usually larger and more brightly coloured than in Pomerania. (2) In Pomeranian plants, on the other hand, the corolla-lobes are on the average somewhat broader. (3) In Pomeranian plants, as a rule, the opening of the corolla and its tube are markedly wider. (*Cf.* Fig. 245.)

In Greenland, according to Abromeit ('Bot. Ergeb. von Drygalski's Grönlandsexped.,' pp. 39–40), the var. *mistassinica* (Mchx.) Pax occupies a middle position between P. farinosa, var. *typica*, and P. stricta *Hornem.* The flowers are homostylous, an oecological peculiarity shared with Menyanthes trifoliata in the same country, for the European type-forms of both plants are heterostylous.

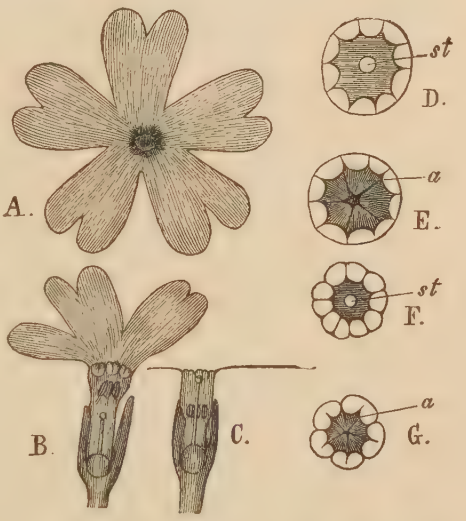


FIG. 245. *Primula farinosa*, *L.* (after Herm. Müller). *A.* A short-styled flower from the Alps, seen from above. *B.* Do., partly dissected, and the limb of the corolla bent upwards. *C.* A long-styled flower, partly dissected (× 2½). *D.* Average width of the entrance of long-styled flowers from North Germany. *E.* Do. of short-styled flowers. *F.* Do. of long-styled Alpine flowers. *G.* Do. of short-styled Alpine flowers. *a*, anthers; *st*, stigma.

VISITORS.—Herm. Müller observed 42 Lepidoptera, 3 Bombyliids, 2 Syrphids, a humble-bee, and a wasp in the Alps. MacLeod saw 2 Lepidoptera, and a Bombyliid in the Pyrenees.

1820. P. minima L. (Herm. Müller, 'Alpenblumen,' p. 369; Schulz, 'Beiträge,' II, pp. 148, 223; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 396.)—This species bears dimorphous heterostylous butterfly flowers. The tube of the rose-red corolla is lined with hairs, and is 10–12 mm. long with a contracted opening, so that only the proboscis of a lepidopterous insect can conveniently reach the base of the flower. Kerner says that automatic self-pollination is possible in the short-styled flowers by fall of pollen.

VISITORS.—Schulz observed Lepidoptera.

1821. P. longiflora All. (Darwin, 'Forms of Flowers,' p. 50; Herm. Müller, 'Alpenblumen,' p. 369; Schulz, 'Beiträge,' II, pp. 146–7, 223; Pax, Bot. Jahrb., Leipzig, x, 1888, p. 227; Ricca, Atti Soc. ital. sc. nat., Milano, xiii, p. 260; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 396–7.)—This species bears diurnal hawk-moth flowers, described by Darwin as homostylous, and by Ricca and Pax as protandrous. The corolla-tubes are 16–24 mm. long, so that only diurnal hawk-moths are able to suck all the nectar from the longest of them.

Kerner, however, states that this species is heterostylous, and that the short-styled stocks flower before the long-styled ones. Autogamy by the fall of pollen is possible in the former.

Visitors.—Schulz observed the diurnal hawk-moth Macroglossa stellatarum *L.* (proboscis 25–8 mm. long).

1822. P. Allionii Loisel. (?) (Schulz, 'Beiträge,' II, pp. 148–9, 223.)—Pax (Bot. Jahrb., Leipzig, x, 1888, p. 230) says that the plant observed by Schulz at San Martino Castrozza, and named as above, is probably P. tirolensis *Schott*, for P. Allionii *Loisel.* does not grow there. The flowers are heterostylous.

Visitors.—Schulz observed Lepidoptera.

1823. P. Auricula L. (Sprengel, 'Entd. Geh.,' p. 102; Schulz, 'Beiträge,' II, p. 148; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 396–7; Knuth, 'Bloemenbiol. Bijdragen.')—The stocks of this species which bear long-styled flowers come into bloom earlier than those bearing short-styled ones. In the former autogamy takes place towards the end of anthesis, for the corolla falls off and the stigma is self-pollinated by being drawn through the whorl of anthers.

Visitors.—I observed the brimstone butterfly (Rhodocera rhamni *L.*), skg., and Schulz also saw butterflies.

1824. P. glutinosa Wulf. (Kerner, op. cit.)—Autogamy is brought about in the long-styled flowers as in the last species.

1825. P. scotica Hook. (=P. farinosa *L.*, according to the *Index Kewensis*). —This species bears homostylous butterfly (?) flowers. The stigma and anthers are usually at the same level and close together, both on the Dovrefjeld (Lindman) and at Tromsø (Warming). In rare cases the anthers are a little higher than the stigma. Automatic self-pollination is therefore unavoidable, and this is effective, for the setting of fruits has been observed, but only casual insect-visits (from Lepidoptera). Scott, on the contrary, describes the species as self-sterile.

Visitors.—*Vide supra.*

1826. P. stricta Hornem. (Warming, 'Bestövningsmaade,' p. 7, 'Arkt. Växt. Biol.,' pp. 21–5.)—This species bears lepidopterid flowers. Warming examined it in Greenland, where he says stigma and anthers are at the same level, so that as the flowers are homogamous, automatic self-pollination is inevitable. In Norway the plant is feebly protandrous, and the stigma is situated at a variable height a little above the anthers. Short-styled flowers have not been noticed. Autogamy is thus rendered more difficult. On the Dovrefjeld only one form has been observed, in which the stigma is somewhat higher than the anthers. Scott describes the species as heterostylous.

1827. P. sibirica Jacq. (Warming, 'Arkt. Växt. Biol.,' pp. 25–7.)—This species bears heterostylous or homostylous lepidopterid (?) flowers. Warming observed markedly heterostylous blossoms by the Altenfjord, and a homostylous one by the Kåfjord, in which the stigma and anthers were at the same level, so that automatic self-pollination was inevitable.

1828. P. egaliksensis Wormsk.—Warming describes this species as homostylous.

1829. P. saccharata Mill.—

Visitors.—Loew observed the bee Anthophora pilipes *F.* ♂, skg., in the Berlin Botanic Garden.

1830. P. sinensis Sabine. (Ljungström, Bot. Not., Lund, 1884, pp. 171–4.)—Ljungström observed cleistogamous flowers on plants of this species cultivated under glass. These possessed a bell-shaped calyx, and a short closed tubular corolla, with faint indications of lobes, and of a pale yellowish green colour. The anthers were very small, and also the pollen-grains, these being only 14 μ long, while those of the long- and short-styled chasmogamous flowers were respectively 32 μ and 24 μ in length. One plant was long-styled, with the style bent in the middle and enclosed in the corolla. In short-styled flowers the style was straight. Fruits and seeds were not observed.

544. Hottonia Boerh.

Flowers heterostylous dimorphous, with concealed nectar, secreted at the base of the ovary and stored up in the corolla-tube. Sometimes cleistogamy.

1831. H. palustris L. (Darwin, 'Forms of Flowers,' pp. 50, 52, 252, 254; Sprengel, 'Entd. Geh.,' p. 103; John Scott, J. Linn. Soc., Bot., London, viii, 1865; Herm. Müller, 'Fertilisation,' pp. 386–9, 'Weit. Beob.,' III, p. 65; Knuth, 'Bloe-

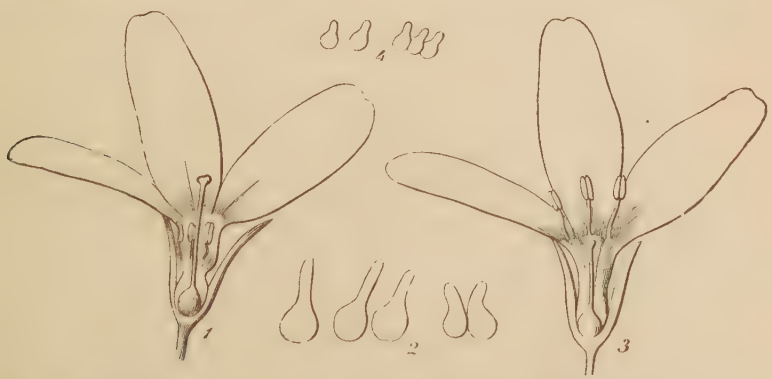


Fig. 246. *Hottonia palustris*, *L.* (after Herm. Müller). (1) Long-styled flower. (2) Stigmatic papillae of do. (3) Short-styled flower. (4) Stigmatic papillae of do., enlarged to same scale as (2).

menbiol. Bijdragen'; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 446–7.)—Sprengel discovered heterostyly in this species, about which he makes the following remarks (loc. cit.):

'Some plants only bear flowers with stamens inside the corolla-tube but the style projecting from it, and others only flowers with the style shorter and the stamens longer than the tube. I do not believe that this is accidental, but an arrangement of Nature, though I am unable to explain its meaning.'

The corolla-tube of the white or reddish flowers is 4–5 mm. long, and the shorter reproductive organs are placed in its opening, while the longer ones project 3–4 mm. from it. Insect visitors when probing for nectar touch the two kinds of organ with different parts of their bodies, and thus regularly effect legitimate crossing.

Visitors which collect or devour pollen touch only the anthers and not the stigma in the short-styled flowers, though this may cause pollen to fall down on the latter, while when they push their heads into the long-styled flowers they touch the stigma and may bring about illegitimate union.

John Scott and Hermann Müller repeated on this species the crossing experiments carried out by Darwin on Primula, and they both came to the same conclusion as he did, i. e. that legitimate unions are most fertile. Müller further found that autogamy and crosses between flowers on the same stock gave still worse results than illegitimate unions, but that, on the contrary, illegitimate union between different stocks of long-styled flowers resulted in fertility as high as that produced by legitimate unions.

O. Appel tells me in a letter that he found a number of plants living in comparatively deep water in swampy ground near Schweinfurt which did not reach to the surface, but nevertheless had set normal fruits. In this case it is clear that pollination took place before the flowers opened, after which the petals expanded. These flowers were smaller and paler than normal ones.

Visitors.—The following were observed by Herm. Müller.—

A. Diptera. (*a*) *Empidae*: 1. Empis chioptera *Fall.* ♀, skg.; 2. E. livida *L.*, freq.; 3. E. pennipes *L.*, freq., skg.; 4. E. rustica *Fall.*, skg.; 5. E. vernalis *Mg.*, freq. (*b*) *Muscidae*: 6. Anthomyia sp., skg.; 7. Aricia incana *Wiedem.*, skg.; 8. Siphona geniculata *Deg.*, skg. (*c*) *Syrphidae*: 9. Eristalis arbustorum *L.*, not infrequent, skg. and po-dvg.; 10. E. nemorum *L.*, do.; 11. Rhingia rostrata *L.*, freq., skg. **B. Hymenoptera.** *Sphegidae*: 12. Pompilus viaticus *L.*, skg.

The following were recorded by the observers, and for the localities stated.—

MacLeod (Belgium), the honey-bee, an Eristalis, a butterfly (Pieris sp.), and a beetle. Knuth, the hover-fly Eristalis tenax *L.*, skg. and effecting legitimate crossing; (between Plön and Eutin), the butterfly Anthocharis cardamines *L.* ♂, skg., and 4 hover-flies, skg., and po-dvg. in short-styled flowers—1. Eristalis intricarius *L.*; 2. E. tenax *L.*; 3. Rhingia rostrata *L.*; 4. Syrphus sp.

545. Cortusa L.

1832. **C. Matthioli** L.—Kerner describes this species as protogynous. The stigma matures in the bud, and projects from the pendulous flowers before they open. According to Scott this plant is undoubtedly self-sterile, but Treviranus states (Bot. Ztg., Leipzig, xxi, 1863) that other species of the genus are autogamous, the style bending back towards the anthers.

546. Dionysia.

According to Kuhn (Bot. Ztg., Leipzig, xxv, 1867), species of this genus are dimorphous.

547. Gregoria.

1833. **G. vitaliana** L.—Kuhn and Kirchner describe this species as heterostylous.

548. Dodecatheon L.

Undoubtedly pollen flowers with pollen guides. Kerner states that the same kind of autogamy takes place as in Soldanella ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 333. *Vide infra*).

1834. D. Meadia L. (=D. frigidum *Cham. et Schlecht.*, and D. integrifolium *Michx.*). (Loew, 'Blütenbiol. Beiträge,' I, pp. 17–19.)—The flower mechanism of this North American species resembles that of Cyclamen (*cf.* p. 79). As the flowers wither they become erect and the anthers separate so that pollen can fall upon the stigma, allogamy being thus replaced by autogamy.

K. Brandegee (Zoë, San Diego (Cal.), i, 1890, pp. 17–20) says that D. Jeffreyi *Moore*, described by Loew (op. cit., p. 463), is a variety of this species. In D. frigidum *Cham. et Schlecht.* the filaments are so short that they are completely enclosed in the throat of the corolla, from which they project for about 3 mm. in the main type. This difference results in an important modification in the flower mechanism, for in the former case visitors cannot cling to the staminal cone.

Visitors.—Loew saw a small bee (Andrena fulva *Schr.*) alight on the staminal cone and fly away again after a short time without obtaining any booty.

549. Soldanella L.

Bee-flowers, usually homogamous, rarely protogynous, sometimes with concealed nectar (S. pusilla *Baumg.*, var. *inclinata*). This is secreted by a ring below the ovary, and stored in the base of the corolla-tube.

1835. S. alpina L. (Kerner, 'Schutzmittel d. Bl.,' p. 232, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 368; Ricca, Atti Soc. ital. sc. nat., Milano, xiv, 1871; Herm. Müller, 'Alpenblumen,' pp. 369–71; Schulz, 'Beiträge,' II, pp. 149–50.)—This species bears bee-flowers. The stigma projects a little from the violet corolla, so that it is first touched by humble-bee visitors, which consequently effect crossing. Müller describes the flowers as homogamous, Ricca and Kerner as protogynous. Should insect-visits fail, Müller says that automatic self-pollination may be effected by the fall of pollen in the vertical flowers, while Kerner states that it is brought about when the corolla drops off, for the stigma is then drawn through the anthers. (*Cf.* Fig. 247.)

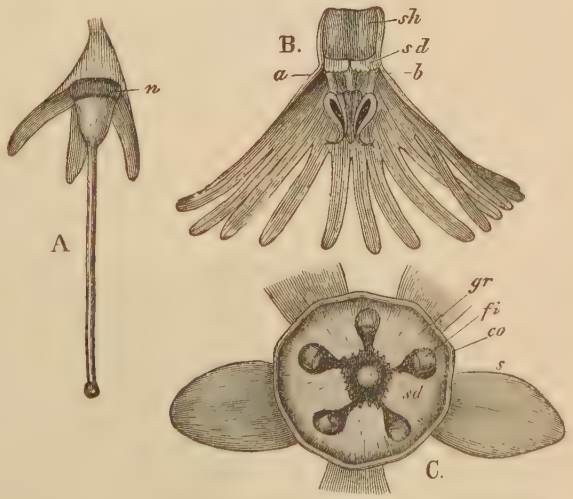


Fig. 247. *Soldanella alpina*, *L.* (after Herm. Müller). *A*. Pistil and half the calyx, seen from the side (× 3½). *B*. Partly dissected flower (× 3½). *C*. Flower cut through immediately below the nectar-covers (as indicated by *ab* in *B*), seen from below (× 7). *co*, corolla; *fi*, filaments; *gr*, style; *n*, nectary; *s*, sepal; *sd*, nectar-cover; *sh*, nectar.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 4 humble-bees, 4 Lepidoptera, and a Syrphid. Kerner (Alps), Apis and 4 humble-bees. MacLeod (Pyrenees), only a Muscid (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 373).

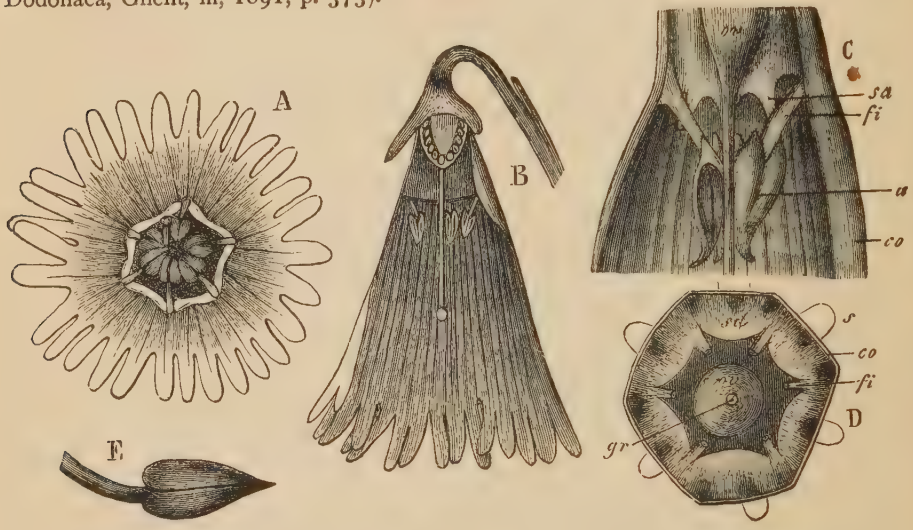


Fig. 248. *Soldanella pusilla, Baumg.* (after Herm. Müller). *A.* Flower seen immediately from below (× 3). *B.* Do. in longitudinal section (× 3). *C.* Part of the same further enlarged (× 7). *D.* Flower cut through immediately below the nectar-covers and seen from below (× 7). *E.* A stamen of *S. minima*. *a*, anthers; *co*, corolla; *fi*, filament; *gr*, style; *ov*, ovary; *s*, sepal; *sd*, nectar-cover.

1836. **S. pusilla** Baumg. (Herm. Müller, 'Alpenblumen,' pp. 371–3; Schulz, 'Beiträge,' II, pp. 150–1.)—Hermann Müller says that this homogamous species occurs in the Alps in two varieties which differ both morphologically and oecologically. The variety *pendula* bears bee-flowers, while in the variety *inclinata* (Fig. 249) the nectar is accessible to less intelligent short-tongued insects. In the former the bell is pendulous and relatively long and narrow, while in the latter it is wider and directed obliquely downwards. In both varieties automatic self-pollination by fall of pollen is possible.

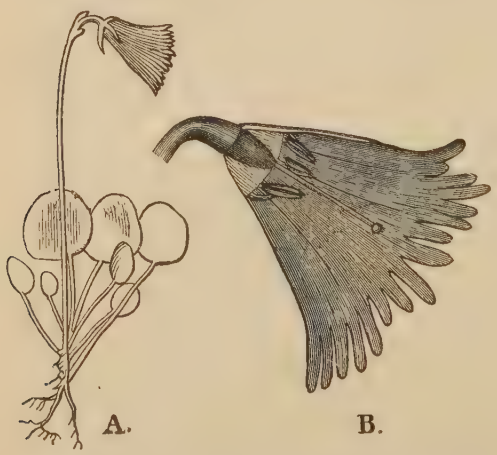


Fig. 249. *Soldanella pusilla, Baumg.*, var. *inclinata* (after Herm. Müller). *A.* Entire plant, natural size. *B.* A flower, partly dissected from the side.

Visitors.—The following were recorded by the observers stated.—

Herm. Müller (on *pendula*), a humble-bee and a beetle; (on *inclinata*) 3 Muscids and a moth. Schulz, 20 bees (including Bombus alticola *Krchb.*) and various flies and beetles.

1837. S. minima Hoppe. (Schulz, 'Beiträge,' II, p. 191.)—The conical flowers of this species are 8–15 mm. long, and project almost at right angles from the main axis, so that automatic self-pollination is rendered difficult in spite of the homogamy.

Visitors.—Schulz saw 2 bees and 7 flies.

550. Cyclamen L.

Protandrous pollen flowers, from which visitors perhaps obtain sap by boring the delicate tissue of the corolla-tube. The anthers make up a sprinkling arrangement, as in Borago. Their lobes dehisce by terminal pores, and are produced into stiff appendages against which visitors strike. Automatic self-pollination is ultimately effected by strong downward inclination of the peduncle, bringing the stigma into the line of fall of the pollen (*cf.* Fig. 250).

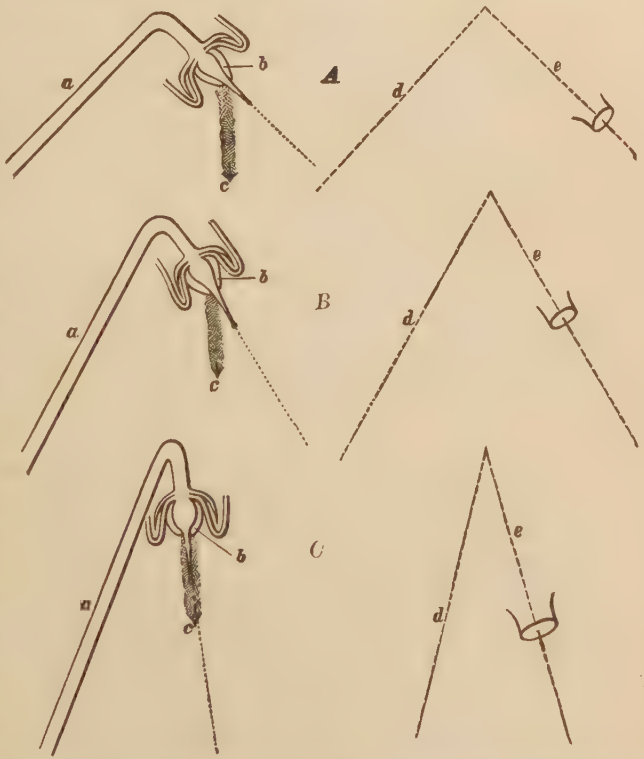


Fig. 250. *Cyclamen latifolium, Sibth. et Sm.* (from Kerner, after Ascherson). *A.* Diagram of the parts of the flower at the beginning of anthesis. The direction in which the pollen falls is far removed from the stigma. *B.* Do. at time of complete development. By further bending of the peduncle the line of fall of the pollen is brought nearer the stigma. *C.* Do. at the end of anthesis. The stigma is now in the line of fall of the pollen. *a*, peduncle; *b*, cone of anthers: *c*, line of fall of the pollen; *d*, *e*, direction of basal and terminal parts of the peduncle (and of the style).

According to Hildebrand (Ber. D. bot. Ges., Berlin, xv, 1897, pp. 292–8), the species of Cyclamen are at first entomophilous and afterwards anemophilous, as in the cases of Calluna vulgaris, Erica carnea, and Bartsia alpina described by Kerner ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 129). The pollen-grains are at first covered by sticky oil, but later on cease to be adhesive and become pulverulent. Although the anthers usually dehisce in the bud autogamy cannot take place, partly owing to the initial stickiness of the pollen and partly

because of the position of the stigma. In C. ibericum *Goldie* and C. Coum *Mill.* the dehisced pollen is held fast by a protective circlet above the stigma. Club-shaped hairs at the base of the ovary appear to serve as food for insects.

1838. C. europaeum L. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 379.)—On the first day of anthesis the peduncle of this species is bent almost at right angles. The angle subsequently increases about 10° a day, so that towards the end of anthesis the short downwardly bent terminal part of the peduncle and the long upright basal part are nearly parallel. It follows that autogamy is at first impossible, but crossing can be brought about by insect visitors, for the stigma projects to some extent beyond the anthers. The bending of the peduncle at last renders automatic self-pollination possible by bringing the stigma into the line of fall of the pollen. Coulter observed cleistogamous flowers (Bot. Gaz., Chicago (III), viii, 1883, pp. 211–12).

1839. C. latifolium Sibth. et Sm. (=C. persicum *Mill.*). (Ascherson, Ber. D. bot. Ges., Berlin, x, 1892, pp. 226–35.)—The flower mechanism of this species agrees entirely with that of C. europaeum. Darwin describes the flowers as self-sterile.

Visitors.—Hildebrand observed numerous honey-bees in the Freiburg Botanic Garden, po-cltg. and apparently skg.; also a small humble-bee, po-cltg., and Xylocopa violacea *L.*, as a casual visitor.

1840. C. hederaefolium Ait. (=C. repandum *Sibth. et Sm.*). (Knuth, 'Blütenbiol. Beob. a. d. Ins. Capri,' pp. 10–13.)—The flower mechanism of this species agrees with that of C. europaeum. The reflexed corolla-lobes surround the opening of the flower (5 mm. wide), from which the style with its small stigma projects 2–3 mm. The five stamens are enclosed in the almost hemispherical corolla-tube, and converge to form a cone which closely surrounds the base of the style.

Visitors.—Hildebrand observed Apis and Bombus sp., skg., in the Freiburg Botanic Garden. This conspicuous species is common below Monte St. Michele on the east coast of Capri, but I observed no visitors on its faintly fragrant flowers.

1841. C. ibericum Goldie.—

Visitors.—Hildebrand observed Apis, po-cltg., in the Freiburg Botanic Garden.

1842. C. neapolitanum Tenore (Knuth, op. cit.).—The flower mechanism of this species is the same as that of C. europaeum.

551. Samolus L.

1843. S. Valerandi L. (MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 447; Schulz, 'Beiträge,' I, p. 89; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 341; Knuth, 'Bloemenbiol. Bijdragen.')—Plants of this species which I examined in Schleswig-Holstein agreed as to their flower mechanism with others examined by MacLeod in Belgium. The corolla-tube is only 1½ mm. deep and encloses the ovary, which bears a ring resembling a nectary in shape and position, but secreting no nectar. The anthers are at the same level in the corolla-tube as the stigma, which matures simultaneously. As they converge towards the latter and dehisce

introrsely automatic self-pollination is inevitable. This is effective, for the flowers are completely fertile, although insect-visits are extremely rare. The throat of the corolla bears five white appendages, which perhaps enhance conspicuousness.

Visitors.—I once observed a small hover-fly (Syritta pipiens *L.*), po-dvg. Owing to the small distance between anthers and stigma it could effect cross- and self-pollination with equal facility.

552. Glaux L.

Verhoeff states that concealed nectar is secreted in very small quantities and stored in the bases of the small flowers, which are of a pale rose colour [1].

1844. G. maritima L. (Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 120; Francke, 'Beiträge zur Kennt. d. Bestäubungseinricht. d. Pfl.,' Halle, 1883.)—I find this species to be homogamous in Schleswig-Holstein. The anthers and stigma mature immediately after the small flowers have opened. As they are at the same level, and the pollen-covered surfaces of the anthers are turned towards the stigma, automatic self-pollination is inevitable. This is effective, for all the flowers without exception set fruits, although insect-visits are extremely few.

Francke, however, describes the flowers as protandrous with anthers remote from the stigma, so that autogamy is impossible. He says nothing about the way in which pollination is effected.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Nordstrand, 31. 5.'93), a minute Muscid (Siphonella palposa *Fall.*) with its head deeply sunk in the flowers. Verhoeff (Norderney).—**Diptera.** (*a*) *Empidae*: 1. Hilara quadrivittata *Mg.*, skg. (*b*) *Muscidae*: all skg.: 2. Anthomyia sp.; 3. Aricia incana *Wiedem.*: 4. Cynomyia mortuorum *L.* 2 ♂; 5. Lucilia caesar *L.*; 6. Onesia floralis *R.-D.* a ♀.

LXV. ORDER *OLEACEAE* LINDL.

Flowers entomophilous, attracting insects by the corolla, an odour which is often powerful, and aggregation into cymose inflorescences. Nectar secreted by the ovary, and concealed in a more or less elongated corolla-tube. Some species are anemophilous (Fraxinus excelsior).

553. Ligustrum L.

Flowers homogamous, in crowded cymes; with concealed nectar secreted by the ovary.

1845. L. vulgare L. (Herm. Müller, 'Fertilisation,' pp. 393–4, 'Weit. Beob.,' III, pp. 62–3; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 103, 163–4.)—Hermann

[1] I was unable to detect free nectar in the flowers of plants from Kiel (June, 1892), Nordstrand (May, 1893), and Sylt (July, 1898). But when treated with orthonitrophenylpropionic acid they assumed a bright violet colour, especially in the central part of the perianth leaves where these abut upon the ovary. Sugar-containing tissue must therefore be present there. (*Cf.* the note on Leucojum aestivum *L.*)

Müller describes the strongly odorous white flowers of this species as possessing a corolla-tube scarcely 3 mm. long and expanding above into a four- or rarely five-lobed limb. The bilobed stigma is situated in the entrance to the flower, while the two or rarely three stamens project freely from it. The anthers dehisce laterally, but so widely that their inner surfaces are entirely covered with pollen. The position of the anthers as regards the stigma is variable. Sometimes they diverge widely, so that an insect visitor usually touches an anther with one side of its body and the stigma with the other, thus effecting crossing: sometimes they bend over the stigma, so that insect-visits can easily bring about autogamy, which can also readily take place automatically.

FIG. 251. *Ligustrum vulgare, L.* (after Herm. Müller). (1) Flower seen obliquely from above. (2) A flower less widely open, seen directly from above. (3) and (4) Flowers seen from the side after removal of half the corolla. (× 3½.)

VISITORS.—Herm. Müller (H. M.) in Westphalia and Thuringia (T.), and Buddeberg (Budd.) in Nassau, observed the following.—

A. Coleoptera. (*a*) *Cerambycidae*: 1. Cerambyx cerdo *L.* (should be *Scop.*), often creeping in the flowers, but taking nothing from them (Budd.). (*b*) *Cleridae*: 2. Trichodes apiarius *L.*, burying its head among the flowers (Budd.). (*c*) *Nitidulidae*: 3. Cercus pedicularius *L.*, skg. (H. M.). (*d*) *Scarabaeidae*: 4. Cetonia aurata *L.*, gnawing the flowers (H. M., T., Budd.). **B. Diptera.** (*a*) *Empidae*: 5. Empis livida *L.*, freq., skg. (H. M.). (*b*) *Syrphidae*: 6. Eristalis arbustorum *L.*, skg. (H. M., T.); 7. E. nemorum *L.*, do. (H. M.). **C. Hymenoptera.** *Apidae*: 8. Apis mellifica *L.* ☿, skg. (H. M., T.); 9. Heriades truncorum *L.*, do. (H. M.); 10. Nomada succincta *Pz.* ♀, do. (H. M., T.). **D. Lepidoptera.** All skg. (*a*) *Pyralidae*: 11. Scoparia ambigualis *Tr.* (Budd.). (*b*) *Rhopalocera*: 12. Coenonympha arcania *L.* (H. M., T.); 13. C. pamphilus *L.* (H. M., T.); 14. Epinephele janira *L.* (H. M., T.); 15. Melitaea athalia *Esp.* (H. M., T.); 16. Thecla pruni *L.* (H. M., T., Budd.). (*c*) *Sphingidae*: 17. Sesia asiliformis *Rott.* ♀ (H. M., T.).

The following were recorded by the observers, and for the localities stated.—

Knuth (Föhr), 6 hover-flies, 2 Lepidoptera, and 2 Muscids: (Rügen), the humble-bee Bombus terrester *L.* ☿, skg. Rössler (Wiesbaden), 3 Lepidoptera—1. Limenitis camilla *S.V.*; 2. Doloploca punctulana *S.V.*; 3. Aedia funesta *Esp.* Schletterer (Tyrol), the bee Andrena carbonaria *L.* MacLeod (Flanders), small flies and the beetle Meligethes (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 372). Loew (Berlin Botanic Garden), a Syrphid (Eristalis nemorum *L.*) and a bee (Apis mellifica *L.* ☿, skg.).

554. Phillyrea L.

Kerner states that the species of this genus are protogynous.

1846. P. latifolia L.—

VISITORS.—Schletterer observed the carpenter-bee Xylocopa violacea *L.* at Pola.

555. Syringa L.

Flowers homogamous, rarely protandrous or protogynous; aggregated into large conspicuous inflorescences; with concealed nectar, secreted in the base of the corolla-tube by the ovary.

1847. S. vulgaris L. (Sprengel, 'Entd. Geh.,' pp. 47–8; Herm. Müller, 'Fertilisation,' pp. 392–3, 'Weit. Beob.,' III, p. 62; Kirchner, 'Flora v. Stuttgart,' p. 537; Warnstorf, Schr. natw. Ver., Wernigerode, xi, 1896; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 103, 164.)—The flowers of this species, and also those of the two following ones, are bluish-lilac, rarely white in colour, fragrant, and aggregated into large conspicuous inflorescences. They are usually homogamous, more rarely protandrous or protogynous according to Batalin (Bot. Ztg., Leipzig, xxviii, 1870, pp. 54–5). The corolla-tube is 8–10 mm. long and about 2 mm. in diameter. Its lower part is filled for 2–4 mm. by the nectar which the ovary secretes abundantly. The anthers are situated in the entrance of the flower at a higher level than the stigma, so that the proboscis of an insect-visitor will first touch the former and then the latter. This does not result, however, in self-pollination of the homogamous flowers, the reason being that pollen does not adhere to the proboscis when it is pushed in, but only during withdrawal, after it has been moistened with nectar. Insects which suck nectar will therefore regularly effect crossing, but those which devour pollen always bring about autogamy. Should insect-visits fail, the latter takes place automatically by fall of pollen upon the stigma. Kerner says that during the early days of anthesis autogamy is rendered difficult because the anthers are turned outwards, but when they shrivel later on it can easily take place.

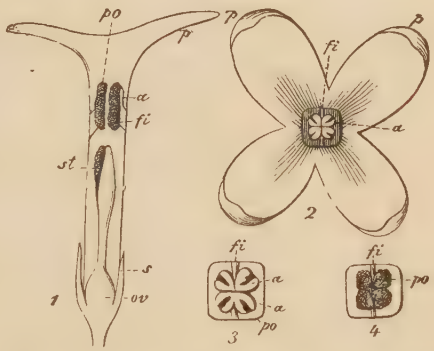


FIG. 252. *Syringa vulgaris*, *L.* (after Herm. Müller). (1) Flower after removal of half the corolla. (2) Flower seen from above. (3) Entrance of a flower immediately after opening. (4) Do., rather later. *a*, anthers; *fi*, filaments; *ov*, ovary; *p*, petals; *po*, pollen; *s*, sepals; *st*, stigma.

Warnstorf describes the pollen-grains as yellow in colour, more or less ellipsoidal, longitudinally furrowed, closely beset with a network of tubercles, up to 50 μ long and 30 μ broad.

VISITORS.—Herm. Müller gives the following list for Westphalia.—

A. Diptera. (*a*) *Bombyliidae*: 1. Bombylius major *L.*, skg. (*b*) *Syrphidae*: 2. Eristalis arbustorum *L.*, po-dvg.; 3. E. sepulcralis *L.*, po-dvg.; 4. Rhingia rostrata *L.*, extremely frequent, skg. and po-dvg.; 5. Syritta pipiens *L.*, po-dvg.; 6. Xylota segnis *L.*, vainly trying to suck, and then po-dvg. **B. Hymenoptera.** (*a*) *Apidae*: 7. Anthophora pilipes *F.* ♀ and ♂, freq., skg.; 8. Apis mellifica *L.* ☿, numerous, skg. and po-dvg.; it pauses in its flight, without settling, before different flowers, until one in a suitable condition is found. 9. Bombus hortorum *L.* ♀ and ☿, very numerous, skg.; 10. B. lapidarius *L.* ☿ and ♀, numerous, skg.; 11. B. terrester *L.* ☿ and ♀, skg.; 12. Eucera longicornis *L.* ♂, do.; 13. Halictus albipes *F.* ♀, do.; 14. Osmia rufa *L.*

♀, freq., skg. (*b*) *Vespidae*: 15. Odynerus sp., vainly searching for nectar and going away at once. **C. Lepidoptera.** (*a*) *Rhopalocera*: 16. Anthocharis cardamines *L.*; 17. Papilio machaon *L.*; 18. P. podalirius *L.*; 19. Pieris brassicae *L.*, freq.; 20. P. napi *L.*, freq.; 21. P. rapae *L.*, freq.; 22. Vanessa io *L.*, skg.; 23. V. urticae *L.*, freq. (*b*) *Sphingidae*: 24. Macroglossa fuciformis *L.*, in large numbers, skg.; 25. M. stellatarum *L.*, do.

The following were recorded by the observers, and for the localities stated.—

Knuth (North Frisian Islands and Kiel), the honey-bee, 2 humble-bees, 3 butterflies (Pieris sp.), and 4 hover-flies. C. Schröder (Rendsburg), 3 species of hawk-moth, freq. (1. Sphinx ligustri *L.*; 2. Deilephila elpenor *L.*; 3. D. porcellus *L.*), and numerous Noctuids: all skg. Alfken (Bremen).— **A. Coleoptera.** *Elateridae*: 1. Corymbites pectinicornis *L.* **B. Hymenoptera.** (*a*) *Apidae*: 2. Apis mellifica *L.*; 3. Bombus hortorum *L.* ♀; 4. B. sylvarum *L.* ♀; 5. B. terrester *L.* ♀; 6. Podalirius retusus *L.* ♀; 7. Psithyrus barbutellus *K.* ♀; 8. P. vestalis *Fourcr.* ♀. (*b*) *Tenthredinidae*: 9. Trichiosoma betuleti *Klg.* (*c*) *Vespidae*: 10. Vespa germanica *F.* ♀. Schenck (Nassau), the parasitic bee Melecta armata *Pz.* Friese (Strasburg), the carpenter-bee Xylocopa violacea *L.* ♀ and ♂, freq.

1848. S. chinensis Willd. (Kirchner, 'Flora v. Stuttgart,' p. 538.)—Kirchner states that this species, like S. vulgaris, is homogamous or feebly protandrous or protogynous, and that its flower mechanism is similar. It is never fertile in Germany.

Visitors.—F. F. Kohl observed the true wasp Leionotus nigripes *H.-Sch.* in the Tyrol.

1849. S. persica L. (Herm. Müller, 'Weit. Beob.,' III, p. 62; Kirchner, 'Flora v. Stuttgart,' p. 538; Knuth, 'Bloemenbiol. Bijdragen.')—The flowers of this species are gynomonoecious. Hermann Müller observed hermaphrodite and female flowers in the same inflorescence. The former are more numerous and of greater size, homogamous, with the stigma in the middle of the corolla-tube and the anthers at its entrance. The anthers of the smaller female flowers are reduced, and generally situated at the same level as the stigma, though sometimes they may be either higher or lower than this, Some of these flowers possess only three corolla-lobes, and others but a single stamen.

In addition to the large hermaphrodite flowers Kirchner noticed here and there smaller ones with non-dehiscing anthers.

Visitors.—Knuth observed the butterfly Pieris napi *L.*, skg.; Herm. Müller the bee Osmia rufa *L.* ♀, do.; and Loew (Berlin Botanic Garden), the humble-bee Bombus hortorum *L.* ♀, do.

556. Forsythia Vahl.

Flowers yellow, homogamous, appearing before the leaves; with concealed nectar. Darwin ('Forms of Flowers') describes the species as heterostylous, but Hildebrand states (Bot. Ztg., Leipzig, lii, 1894) that our gardens contain only the short-styled form of F. suspensa and the long-styled one of F. viridissima. The seeds obtained from the former always grow up into the hybrid F. intermedia (=F. suspensa × F. viridissima).

1850. F. viridissima Lindl. (Herm. Müller, 'Weit. Beob.,' III, p. 63.)—The flower mechanism of this species agrees essentially with that of Ligustrum. The

style usually projects beyond the stamens by about the length of the latter, so that insect visitors must first touch the stigma and then the simultaneously mature anthers, thus effecting cross-pollination. In some flowers, however, the style is so short that the stigma is touched by the anthers, and self-pollination consequently takes place.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Lippstadt), 2 bees (Andrena fulva *Chr.* ♀, skg., and Bombus pratorum *L.* ♀) and the beetle Meligethes (penetrating deeply into the flowers). Alfken (Bremen), the honey-bee, not infrequent.

1851. **F. suspensa** Vahl. (Knuth, 'Bloemenbiol. Bijdragen.')—

Visitors.—I observed the honey-bee, skg.

557. Fraxinus Tourn.

Flowers polygamous. Petals two, four, or absent. Partly anemophilous, partly entomophilous.

1852. **F. excelsior** L. (Kirchner, 'Flora v. Stuttgart,' pp. 538–9; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 381; Schulz, 'Beiträge'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 312; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 104.) —The blossoms of this species are pollinated by the wind, and develop before the leaves. Kirchner states that the female flowers possess stamens, but these soon drop off, and their anthers neither dehisce nor contain mature pollen-grains. Many of the hermaphrodite flowers are infertile.

Schulz describes this species as andromonoecious, gynodioecious, gynomonoecious, and also trioecious. In nearly all cases hermaphrodite flowers are present, so that in Central Germany the sexes are distributed in at least ten different ways.

Kerner asserts that this species is protogynous. The large fleshy stigma matures 2–4 days before the anthers, which are borne on short thick filaments and produce mealy pollen that is scattered by the wind.

1853. **F. Ornus** L.—The flowers of this species smell like hawthorn, and Kerner states that some of them are pseudo-hermaphrodite.

Visitors.—Delpino saw the beetle Melolontha farinosa (no doubt = Hoplia argentea *Poda*) in large numbers ('Ult. oss.,' Atti Soc. ital. sc. nat., Milano, xvi, 1873).

558. Jasminum L.

Treviranus states (Bot. Ztg., Leipzig, xxi, 1863) that autogamy takes place by bending back of the style to the anthers. Kuhn says that some of the species are dimorphous (Bot. Ztg., Leipzig, xxv, 1867).

1854. **J. humile** L. (=J. revolutum *Sims*). (Pirotta, Rend. Ist. Lomb., Milano, Ser. 2, xviii, 1885.)—Pirotta describes this species as heterostylous dimorphous. Both forms are protandrous in the Rome Botanic Garden.

Visitors.—Small beetles and flies, together with bees and other Hymenoptera, have been observed.

1855. J. Sambae Ait.—This species is especially fragrant after sunset.

1856. J. noctiflorum Afzel.—

Visitors.—These appear to be nocturnal Lepidoptera.

559. Nyctanthes L.

1857. N. Arbor-tristis L.—This species bears large fragrant flowers with long corolla-tubes, and most of them are shed at sunrise.

Visitors.—These appear to be nocturnal Lepidoptera.

560. Monodora Dun.

1858. M. longiflora Eng., and **1859. M. pubens** A. Gray.—The large fragrant flowers of these species are of a bright-yellow colour and possess long corolla-tubes. They open in the evening.

Visitors.—These are apparently nocturnal Lepidoptera.

561. Schrebera Roxb.

The flowers are particularly fragrant in the evening.

Visitors.—Judging from the above these would appear to be nocturnal Lepidoptera.

LXVI. ORDER *APOCYNACEAE* R. BR.

Literature.—K. Schumann, 'Apocynaceae,' in Engler and Prantl's 'D. nat. Pflanzenfam.', IV, 2, pp. 115–17.

562. Vinca L.

Flowers herkogamous, with concealed nectar secreted at the base of the ovary.

1860. V. minor L. (Sprengel, 'Entd. Geh.,' pp. 135–7; Herm. Müller, 'Fertilisation,' pp. 394–6, 'Weit. Beob.,' III, p. 62; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 384–5; Kirchner, 'Flora v. Stuttgart,' p. 544; Baillon, Bull. soc. linn., Paris, i, 1882, pp. 323–5; Darwin, Gard. Chron., London, 1861, pp. 552, 831; Crocker, Bull. R. Bot. Gard., Kew, 1861, Gard. Chron., London, 1861, p. 669; F. A. P., op. cit., p. 736; Delpino, 'Sugli appar. d. fecondaz. nelle piante autocarp.,' pp. 15–17; Hildebrand, Bot. Ztg., Leipzig, xxv, 1867, p. 274; Humphrey, Bot. Gaz., Chicago (Ill.), x, 1885, p. 296.)—The flower mechanism of this species was long since described by Sprengel, but he supposed it to be adapted for self-pollination. Darwin and Delpino have both given correct independent accounts of it.—Nectar is secreted by two yellow glands near the ovary, and stored up in the corolla-tube (11 mm. long), the entrance of which is lined by hairs serving as a protection against rain. About the middle of this tube the style thickens conically and terminates in a short cylindrical horizontal plate, the edge of which functions as a stigma and is covered with a sticky secretion. The plate bears a tuft of hairs, which takes up the pollen as it is shed from the anthers. The filaments spring from the middle of the corolla-tube, are bent in a knee-like fashion, and beset with hairs internally. The anthers are situated immediately above the stigmatic disk, and

dehisce introrsely. Their margins are hairy, so that the pollen can only fall upon the terminal brush of the disk. Nectar-seeking insects can insert their heads for several millimetres into the corolla tube, as far as the brush, so that a proboscis 8 mm. long is able to reach the nectar. When this is inserted it gets covered with viscid matter, which takes up pollen on withdrawal, and can therefore effect crossing in the next flower visited. Automatic self-pollination is excluded.

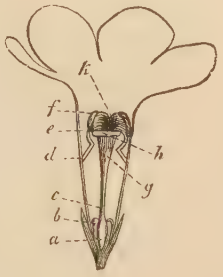


FIG. 253. *Vinca minor*, *L.* (after Herm. Müller). Flower after removal of half the corolla. *a*, ovary; *b*, yellow nectaries; *c*, style; *d*, place where a filament diverges from the corolla, visible externally as a depression; *de*, filament with its inward knee-like bend; *ef*, introrse anther; *g*, thickening of the style; *h*, disk-like process of the style, covered all round with sticky secretion, and with a stigmatic lower edge; *k*, brush of hairs upon the stigmatic disk, which takes up the pollen as it is shed.

VISITORS.—Herm. Müller gives the following list.—

A. Diptera. *Bombyliidae*: 1. Bombylius discolor *Mik.*, very common, skg. legitimately; 2. B. major *L.*, do. **B. Hymenoptera.** *Apidae*: 3. Anthophora pilipes *F.* ♀ and ♂, very common, skg.; 4. Apis mellifica *L.* ☿, tolerably freq., taking all the nectar from the smaller flowers, and part of it from the larger ones; 5. Bombus agrorum *F.* ♀, very common, skg.; 6. B. hortorum *L.*, do.; 7. B. hypnorum *L.* ♀, one, skg.; 8. B. lapidarius *L.* ♀, very common, skg.; 9. B. pratorum *L.* ♀, do. (H. M.; Borgstette, Tecklenburg); 10. B. terrester *L.* ♀, skg.; 11. B. vestalis *Fourcr.* ♀, one, skg.; 12. Osmia fusca *Chr.* ♀, persistently skg.; 13. O. rufa *L.* ♂, skg. **C. Thysanoptera.** 14. Thrips, freq.

The following were recorded by the observers, and for the localities stated.—

Sprengel, only Thrips. Knuth (Kiel churchyard, 26. 4. '96), the humble-bee Bombus hortorum *L.* ♀, occasional, skg., visiting several flowers in succession. Alfken (Bremen), 2 bees—1. Osmia rufa *L.* ♀ and ♂; 2. Podalirius acervorum *L.* ♂. Schletterer (Pola), the bee Andrena deceptoria *Schmiedekn.*

1861. V. major L. (Sprengel, 'Entd. Geh.,' pp. 136–7; Darwin, Gard. Chron., London, 1861, p. 552; Herm. Müller, 'Fertilisation,' p. 396; Knuth, 'Bloemenbiol. Bijdragen'; Baillon, Bull. soc. linn., Paris, i, 1882.)—The flower mechanism of this species agrees with that of V. minor. The corolla-tube is 15–16 mm. long, and a proboscis of 11 mm. can secure all the nectar. The flowers are self-sterile. Darwin was able to cause the production of good fruits by effecting artificial pollination with a small brush. Baillon gives a detailed account of the flower mechanism.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Knuth, the humble-bee Bombus hortorum *L.* ♀, skg., repeatedly. Herm. Müller, the humble-bee Bombus agrorum *F.* ♀, skg. numerous flowers. Schletterer (Pola), an Ichneumonid (Bassus laetatorius *F.*) and 6 bees—1. Bombus argillaceus *Scop.*, skg.; 2. B. terrester *L.*; 3. Eucera clypeata *Er.*; 4. E. longicornis *L.*; 5. Podalirius acervorum *L.*; 6. P. crinipes *Sm.*

1862. V. rosea L. (=Lochnera rosea *Reichb.*).—The flower mechanism of this species is the same as that of V. minor.

1863. V. herbacea Waldst. et Kit.—The flower mechanism of this species is the same as that of V. minor.

563. Trachelospermum L.

1864. T. jasminoides Lem.—Hildebrand states that the flower mechanism of this species is the same as that of Vinca.

564. Tabernaemontana Plum.

1865. T. echinata Aubl.—Fritz Müller says that this species is only fertile with the pollen from other stocks (Bot. Ztg., Leipzig, xxviii, 1870, p. 274).

565. Apocynum L.

Flowers homogamous, with concealed nectar, secreted and stored in their bases.

1866. A. androsaemifolium L. (Ludwig, Bot. Centralbl., Cassel, viii, 1881, pp. 184–5.)—Ludwig says that this species bears campanulate whitish flowers with internal red streaks serving as nectar-guides, and five basal nectaries of which the secretion possesses an unpleasant sweetish odour. The short filaments are beset with hairs playing the part of nectar-covers. The five anthers make up a cone surrounding the capitate end of the style. This is divided by a ring into upper and lower parts, the latter serving as a stigma. The inner sides of the stamens, somewhat above the centre of their length, are fused with this ring, so that a chamber is formed into which the pollen falls without touching the stigma. The backs of the anthers are thick angular woody plates, which prevent insects from gnawing away the upper part of the stamens and style so as to make a more convenient way to the nectar. The chinks between the anthers narrow above, and serve as clips to hold fast unbidden guests. The actual pollinators (bees, and the larger hover-flies and Muscids) after sucking nectar are obliged to withdraw their proboscis between the anthers, i. e. through these clips, and it can only be freed by the exercise of considerable force. During this withdrawal the proboscis passes over the stigma, and its sticky upper edge through the pollen-chamber, from which it takes up some of the adhesive granular pollen, to be transferred to the next flower visited. The smaller and weaker insects, which are unable to penetrate the pollen-chamber and are therefore useless guests, remain held fast by the clips to perish miserably. Among these Ludwig observed numerous Muscids (Spilogaster carbonella *Zett.*, Scatophaga merdaria *F.*, Anthomyia pluvialis *L.*), sometimes small Hymenoptera, and occasionally Lepidoptera. The presence of numerous dead flies (and proboscides and limbs of these) in the flowers shows that there must be a large number of these unskilled visitors.

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Coleoptera. (*a*) *Coccinellidae*: 1. Coccinella quattuordecimpunctata *L.*, resting in the flowers. (*b*) *Nitidulidae*: 2. Meligethes sp., nect-lkg. in the bases of the flowers. (*c*) *Ptinidae*: 3. Anobium striatum *Ol.*, in the bases of the flowers. **B. Diptera.** (*a*) *Muscidae*: 4. Anthomyia sp., caught by the proboscis in the flowers; 5. Onesia floralis *R. D.*, do. (*b*) *Syrphidae*: 6. Melanostoma mellina *L.*, caught by the proboscis in the flowers; 7. Platycheirus scutatus *Mg.*, do.; 8. Syritta pipiens, *L.*, do.

1867. A. cannabinum L. (= A. hypericifolium *Ait.*). (Ludwig, op. cit.)—Ludwig describes this species as bearing much smaller, more inconspicuous, greenish or yellowish-white flowers, devoid of nectar-guides, and possessing a still more

disagreeable odour. In other respects their mechanism agrees with that of A. androsaemifolium. In correlation with the duller colouring we find that the only visitors are flies, among which large numbers of the smaller Syrphids and Muscids are imprisoned by the clips.

Ludwig (Kosmos, Stuttgart, viii, 1881) observed that 56 flowers caught and killed 88 small Muscids and Syrphids between early morning and 3 p. m.

Visitors.—*Vide supra.*

1868. A. venetum L.—This species is doubtfully arachnophilous (*cf.* Vincetoxicum officinale, p. 90).

566. Lyonsia R. Br.

According to Loew (Bot. Centralbl., Cassel, xxviii, 1886), the flower mechanism resembles that of Apocynum androsaemifolium. Schumann (op. cit.) noticed that flies were killed by the flowers of species of this genus.

567. Nerium L.

Homogamous Lepidopterid flowers.

1869. N. odorum Ait. (Ludwig, Bot. Centralbl., Cassel, viii, 1881, pp. 185–8.)—The large fragrant flowers of this species possess a large funnel-shaped corolla, which becomes rotate above, and is provided with an incised corona. There are nectar-guides in the form of dark-red streaks converging to the nectar-containing base of the flower. As in Apocynum the corolla-tube encloses a cone of anthers covered externally by woody plates, and fused internally with the dilated end of the style to form a pollen-chamber, beneath which is the stigmatic surface. The anther-plates are produced into points below, and covered with hairs dorsally. Each stamen is drawn out into a long terminal appendage, which is filiform at its base and then becomes broader and feather-like. These five appendages are twisted together into a loose, woolly, whitish ball, 8–9 mm. long and 4 mm. broad, which (with the corona) blocks the entrance of the flower in such a way that only long-tongued Lepidoptera are able to penetrate to the nectar.

Within the flowers Lepidoptera have to overcome the same difficulties as those presented by Apocynum to pollinating agents. Their proboscis can only reach to the base of the flower (about 10 mm. deep) by being inserted into the narrow glabrous fissures between the stamens, and has to be withdrawn between the anthers, through a cleft which narrows above. In the latter operation the stigma is first touched, and gets pollinated if another flower has previously been visited, after which the proboscis is smeared with the viscid secretion of the upper edge of the stigma, and takes up fresh clumps of pollen from the pollen-chamber. All visitors do not possess the necessary strength and endurance for this, so that here again unbidden guests are caught and killed. The observation of two cases of the kind first called the attention of Ludwig to the mechanism of oleander flowers.

Visitors.—The larger Lepidoptera, especially the hawk-moth Sphinx nerii *L.*

1870. N. Oleander L.; **1871. N. cupreum** L.; **1872. N. Grangeanum**; and **1873. N. Ricciardianum.**—Ludwig (op. cit.) says that these species possess the same flower mechanism as N. odorum.

LXVII. ORDER *ASCLEPIADEAE* R. BR.

In the sub-order Cynanchoideae the five filaments are broadened, generally fused into a tube, and provided with external appendages which make up a corona; anthers usually with terminal membranous appendages; pollen aggregated into pollinia, attached in pairs to the clip-glands of the large capitate stigma. The clips grasp the legs of insect-visitors when the nectar-secreting spots are on the same radii as the stamens (Asclepias), or the proboscis if these spots alternate with the stamens (Vincetoxicum, Stapelia, Bucerosia, Araujia). The clips are thus drawn out of their recesses by the legs or proboscis of visitors, and transferred to other flowers. (Pinch-trap flowers.) The extremely specialized flower mechanisms are adapted to insect visitors in a very perfect manner, so that a comparison may be made with orchids, though in this case there is nothing like the same variety.

According to K. Schumann ('Asclepiadaceae,' in Engler and Prantl's 'D. nat. Pflanzenfam.,' IV, 2), the flower mechanism of the sub-order Periplocoideae exhibits an undoubted analogy to that of the Ophryoideae.

568. **Vincetoxicum** Rupp.

Yellowish-white pinch-trap flowers, arranged in axillary stalked umbels, and pollinated by means of the proboscis of insect visitors.

1874. **V. officinale** Moench (=Asclepias Vincetoxicum *L.*, and Cynanchum Vincetoxicum *Pers.*). (Sprengel, 'Entd. Geh.,' pp. 139–50; Delpino, 'Ult. oss.,' pp. 224–8; Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870, pp. 604–5; Herm. Müller, 'Alpenblumen,' pp. 350–2; Kirchner, 'Flora v. Stuttgart,' p. 546.)—The flowers of this species smell of honey. The ovaries are surrounded by a fleshy column formed by fusion of the stamens, and covered by a fleshy disk, under which are five entrances to the stigmas. The staminal column bears the five anthers at its end, and also, externally, five appendages (cuculli) fused together to form a domed corona. The anthers are closely apposed to the terminal knob of the style, and each of them contains a pair of plate-like pollinia lodged in loculi opening on the side turned inwards. The connective is produced into a triangular membranous appendage which is closely applied to the top of the stylar knob. Each side of the anther is continued into a leaf-like wing, narrowing gradually above and vertical to the column of filaments. The adjoining wings of every two anthers bound between them a narrow slit that widens below. These slits open internally into a stigmatic chamber, which is partly bounded by the stigmatic surface on the under-side of the terminal expansion of the style. Lying in the upper part of each slit, and visible externally, is a dark, bilaterally symmetrical shining body (corpusculum), consisting of a hard, thin, horny plate. Its sides are bent forwards for their whole length so that their edges lie close together, and in the middle of its lower border there is a wedge-shaped slit. Two pollinia, lying in the adjacent loculi of two different anthers, are attached by bands to this 'clip.'

If now a fly tries to suck the nectar contained in one of the coronal pits, situated immediately below a clip, its extended proboscis, beset with erect bristles, will be guided upwards in the slit between the adjacent anther-wings until it is

inevitably held fast in the clip. The visitor will then draw back its proboscis with a jerk, pulling away the clip with the two connected pollinia, and carrying them off. When first extracted from their loculi the pollinia are wide apart, but the bands connecting them with the clip twist inwards as they dry, bringing the pollinia so close together that they can easily be introduced into a slit. Should the insect now visit another flower the pollinia are readily pushed into one of the slits, guided by which they will slip into the stigmatic chamber, there to effect crossing, for when the insect draws back its proboscis they are torn away from the bands connecting them with the clip. At the same time a new clip

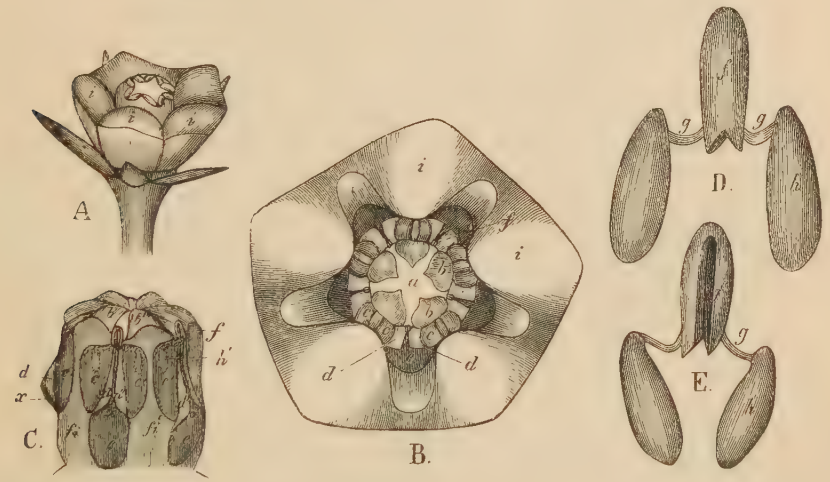


FIG. 254. *Vincetoxicum officinale*, *Moench* (after Herm. Müller). *A*. Flower after removal of the five petals (× 7). *B*. Do. with calyx also removed, seen directly from above (× 14). *C*. The dilated end of the style, surrounded by the anthers. The pollinia lying hidden in the anthers, and the bands connecting them with the clips, are indicated by dotted lines. *D*. Inner side of a clip with attached pollinia (× 80). *E*. Outer side of do. *a*, capitate end of the style; *b*, membranous process of the connective, lying upon *a*; *c*, outer side of loculus; *d*, wing-like lateral margin of anther, which, with the corresponding wing of the adjacent anther, bounds the slit *x* that widens below; *e*, nectar pit; *f*, clip, to which two pollinia (*h*) are attached by bands (*g*); *i*, nectar-secreting coronal appendages (cuculli).

with its pollinia will be attached to the proboscis. It is only to the proboscis bristles of Muscids that the clips regularly get fixed. Other visitors (Empids, Syrphids, wasps, &c.) lack these bristles, and it is exceptional for an insect of the kind to carry off a clip on the end of its proboscis.

F. Heim (Bull. soc. linn., Paris, ii, 1893) says that this species is pollinated by large Diptera, which usually do not succeed in getting nectar. Small flies are also found in the flowers, and these remain sticking in the clips, thus preventing the pollinia from being used for crossing. This is a case of insect-visits being not merely useless, but harmful. Heim believes that spiders protect the flowers against such unwelcome guests, and speaks of this as a case of 'arachnophily.' The same remark applies to Apocynum venetum *L.*

VISITORS.—*Vide supra.* The following were recorded by the observers and for the localities stated.—

Sprengel, flies with clips attached to their proboscis. Herm. Müller (Alps), 12 Muscids, mostly with pollinia attached to their proboscis bristles: also, as

unbidden guests, an Empid, a hover-fly, 2 bees, a fossorial wasp, a true wasp, 2 Lepidoptera, and 4 beetles. MacLeod (Pyrenees), 4 short-tongued Hymenoptera, 3 beetles, and 3 Muscids: none of these bore pollinia (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 344).

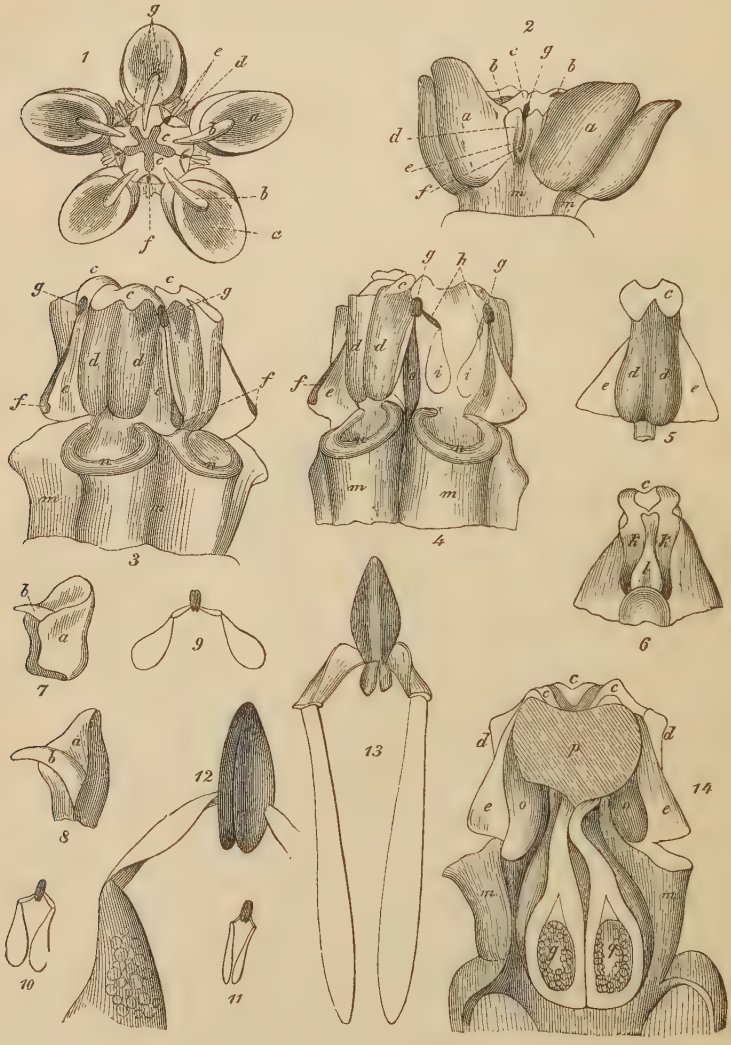


FIG. 255. *Asclepias syriaca*, *L.* (after Herm. Müller). (1) Flower after removal of sepals and petals, seen from above (× 3½). (2) Do., from the side. (3) Do., after removal of the nectar-secreting organs (cuculli) (× 7). (4) Do., after removal of a stamen. (5) The detached stamen, seen from outside. (6) Inner side of do. (7) Nectar-secreting organ (cucullus) (× 3½). (8) Do., in longitudinal section, to show the conical process apposed to an anther. (9) Freshly extracted pollinia, seen from the outside (× 7). (10) Do., when the torsion of the bands is half complete. (11) Do., when the torsion is complete. (12) Longitudinal section of flower, after removal of sepals, petals, and cuculli. *a*, cucullus; *b*, conical process of do.; *c*, membranous process of connective; *d*, outer side of loculus containing a pollinium; *e*, lateral wing of an anther, which with the corresponding wing of the adjacent anther bounds a slit (*f*), into which first the foot of an insect and then a pollinium is introduced; *g*, clip of the upper end of a slit, united by bands (*h*) to two pollinia (*i*), from the adjacent loculi of different anthers; *k*, empty loculus of anther; *l*, connective; *m*, cylinder surrounding the ovary and bearing the cuculli and stamens; *n*, place of attachment of a cucullus; *o*, stigmatic chamber; *p*, fleshy stigmatic disk; *q*, ovary.

1875. V. medium Decne. (=V. latifolium *C. Koch*).—

Visitors.—Plateau saw the hover-fly Melanostoma mellina *L.* in the Ghent Botanic Garden.

1876. V. purpurascens C. Morr. et Decne.—

Visitors.—Plateau saw the house-fly Musca domestica *L.* in the Ghent Botanic Garden.

569. Asclepias L.

Pinch-trap flowers. Pollination effected by the legs of insects.

1877. A. syriaca L. (=A. Cornuti *Decne.*). (Delpino, 'Sugli appar. d. fecondaz. nelle piante autocarp.,' pp. 6–15; Hildebrand, Bot. Ztg., Leipzig, xxiv, 1866, p. 376, xxv, 1867, pp. 265, 273, 281; J. P. Mansel Weale, J. Linn. Soc., Bot., London, xiii, 1873, pp. 48–58; Herm. Müller, 'Fertilisation,' pp. 396–400, 'Weit. Beob.,' III, p. 61; T. H. Corry, Trans. Linn. Soc., Bot., London, Ser. 2, ii, 1884, pp. 173–207, Proc. Phil. Soc., Cambridge, iv, 1883, pp. 5–6; Stadler, 'Beiträge.')—Hildebrand has given the most exhaustive account of the way in which this species is pollinated by insects, while Hermann Müller was the first to publish drawings of the flower mechanism (Fig. 255), which agrees essentially with that of Vincetoxicum officinale.

Fig. 256. *Asclepias syriaca, Decne.* (from K. Schumann, after Payer). *A.* Flower seen from the side: *ca*, calyx; *co*, corolla. *B.* Do., after removal of calyx and corolla, visited by a wasp, to the feet of which some pollinia are attached. *C.* Longitudinal section of flower: *a*, corolla; *anth*, anthers; *fr*, ovary; *na*, stigmatic disk; *st*, stamens.

But while the latter is a pinch-trap flower adapted to nectar-seeking flies, to the proboscis bristles of which its minute clips become attached, Asclepias syriaca bears flowers of a kind adapted to bees, the claws of which become entangled in the clips and carry off the pollinia to be introduced into the stigmatic chambers of other blossoms. As before, an odour of honey is exhaled. The petaloid appendages (cuculli) of the anthers are in the form of five fleshy nectar-pockets, which alternate with the clips. From the bottom of each of these arises a curved horn-shaped process that bends inwards over the stigmatic disk.

An insect searching for nectar slips about on the smooth flowers which make up the umbel until one of its feet gets a firm hold in the lower part of a slit. When it wishes to go on, and draws up the leg, the claws are guided upwards in the slit so that the clip becomes attached to the foot. During subsequent movements the

pollinia are introduced into one of the slits of another flower, and effect cross-pollination, while at the same time another clip affixes itself.

The development of the pollinia was investigated by Corry. He also found that flowers are infertile not only with their own pollen, but also with that derived from plants raised vegetatively from the same stock. Pollination is fully effective only when it takes place between flowers belonging to plants grown from the seeds of different stocks. Stadler worked out the histological details of the secretion of nectar, and found that this is produced not only within the petaloid cuculli, but also by internal nectaries on the inner wall of the stigmatic chamber. The approximated lower edges of the slits serve as nectar-covers for the latter.

Visitors.—Sprengel observed a fly with clips attached to one of its legs. Herm. Müller ('Fertilisation,' p. 399) gives the following list of insects observed by himself (H. M.) in Thuringia, Buddeberg (Budd.) in Nassau, Hildebrand (H.) at Freiburg, and Delpino (D.) at Florence, to which are added some others chiefly noticed by him in his garden at Lippstadt (op. cit., p. 400, 'Weit. Beob.,' III, p. 61). Those with clips attached to their claws are indicated by an asterisk (*).—

A. Diptera. (*a*) *Empidae*: 1. Empis livida *L.*, skg., drawing out the pollinia. (*b*) *Muscidae*: 2. Lucilia sp., do. (H. M., Westphalia and T.); 3. Ocyptera brassicaria *F.* (H.). (*c*) *Syrphidae*: 4.* Eristalis arbustorum *L.* (H. M., T.); 5.* E. nemorum *L.* (H. M., T.); 6.* E. tenax *L.* (H. M., T.); 7. Melithreptus scriptus *L.*, skg., without putting its feet in the slits (H. M., T.); 8. M. taeniatus *Mg.*, do. (H. M., T.). **B. Hymenoptera.** (*a*) *Apidae*: 9.* Apis mellifica *L.* ☿ (H. M., T.; D.); 10. Bombus agrorum *F.* ♂, freq., skg. and pollinating (H. M., Würzburg); 11.* B. hypnorum *L.* ☿ (Budd.); 12.* B. italicus *L.* (D.); 13.* B. terrester *L.* ☿ and ♂ (Budd.); 14.* Coelioxys conoidea *Ill.* ♀ and ♂, freq., skg. and pollinating (H. M.); 15.* C. sp. ♀ and ♂ (Budd.); 16.* Halictus cylindricus *F.* ♂ (Budd.); 17.* H. quadricinctus *F.* ♀ (Budd.); 18.* H. scabiosae *Rossi* ♀ (Budd.); 19. Several small sps. of Halictus, which never put their feet in the slits (H. M.); 20.* Stelis aterrima *Pz.* ♀ (Budd.). (*b*) *Formicidae*: 21. Different sps., caught in the slits (H. M., T.); 22. Myrmica levinodis *Nyl.* ☿, do. (H. M.). (*c*) *Sphegidae*: 23.* Ammophila sabulosa *L.* ♀ (Budd.); 24.* Scolia hirta *Schr.* (D.); 25.* S. flavifrons *F.* (D.); 26.* S. quadripunctata *F.* ♀ (Budd.); 27.* Psammophila affinis *K.* ♀ (Budd.). (*d*) *Vespidae*: 28.* Polistes diadema *Ltr.* (H. M., T.); 29.* P. gallica *L.* ♀ (H. M., T.; Budd.). **C. Lepidoptera.** *Noctuidae*: 30. Hypena proboscidalis *L.*, skg., but not drawing out the pollinia (H. M.); 31. Plusia gamma *L.*, do., in the evening (H. M.). **D. Neuroptera.** 32. Panorpa communis *L.*, skg., and drawing out the pollinia (H. M.).

1878. A. fruticosa L. (=Gomphocarpus fruticosus *R. Br.*). (Sprengel, 'Entd. Geh.,' pp. 139–50.)—Sprengel gives a very thorough account of this species. The flowers smell like honey, and their mechanism agrees with that of A. syriaca.

Visitors.—Sprengel observed a number of flies and wasps in the castle garden at Charlottenburg (22. 8.'89), with clips attached to their feet.

1879. A. curassavica L.—This species also was investigated by Sprengel. Fritz Müller says that in South America, its native country, it is chiefly visited by butterflies, and Hermann Müller depicts the foot of one of these to which 11 clips and 8 pollinia are attached (Fig. 568).

1880. A. tenuifolia L.—

Visitors.—Hildebrand saw this species pollinated by a cabbage white, Pieris brassicae *L.* (Bot. Ztg., Leipzig, xxix, 1871, p. 746).

570. Stapelia L.

Pinch-trap flowers with a carrion odour, which attracts flies fond of putrefying substances. These effect cross-pollination by means of their proboscis. Kuhn observed cleistogamy.

1881. S. hirsuta L., and **1882. S. grandiflora** Mass.—Both these species are native to the Cape.

Visitors.—Delpino noticed two Muscids (Sarcophaga carnaria *L.*, and Calliphora vomitoria *L.*) as pollinators.

571. Gomphocarpus R. Br.

Flower mechanism similar to that of Stapelia. The clips attach themselves to the claws of hymenopterous visitors. (Delpino, 'Sugli appar. d. fecondaz. nelle piante autocarp.,' pp. 3–14; Hildebrand, Bot. Ztg., Leipzig, xxv, 1867, pp. 266–9.)

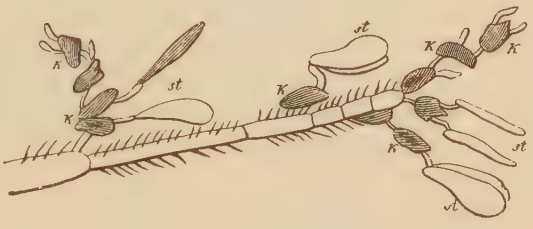


Fig. 257. *Asclepias curassavica*, *L.* (after Herm. Müller). 11 clips (*k*) and 8 pollinia (*st*) attached to a butterfly's foot.

572. Araujia Brot.

1883. A. sericifera Brot. (=A. albens *G. Don*, and Physianthus albens *Mart.*). (Delpino, op. cit.; Hildebrand, op. cit.; A. Rogenhofer, SitzBer. ZoolBot. Ges., Wien, xl, 1890, pp. 67–8.)—In this species the pollinators are humble-bees, and the clips attach themselves to the proboscis. A. Rogenhofer saw a moth (Plusia gamma *L.*) hanging dead from the flower, while strong humble-bees cannot be held fast, but tear away the clips.

Visitors.—*Vide supra.*

573. Boucerosia Wight et Arn.

Delpino (op. cit.) states that the flower mechanism resembles that of Araujia.

574. Hoya R. Br.

Delpino (op. cit.) states that the clips become attached to the legs of visitors.

1884. H. carnosa R. Br. (Delpino, 'Sugli appar. d. fecondaz. nelle piante autocarp.,' p. 9; Darwin, 'Forms of Flowers,' p. 331.)—Delpino saw numerous bees visit this species at Florence, drawing out the pollinia upon their claws. From one plant which was carefully examined four-fifths of the pollinia had been removed from their loculi, and some with germinating pollen-grains were found upon the stigmas. This plant, however, and some from other Italian gardens, remained completely sterile. Delpino suggests as a reason that all the stocks had been vegetatively propagated from one and the same original plant.

Darwin mentions cleistogamous flowers devoid of pollen one of which produced a capsule in which seeds were (? parthenogenetically) developed. These appeared normal, but were incapable of germination.

Visitors.—*Vide supra.*

1885. H. globulosa Hook. f. (W. G. Smith, Gard. Chron., London, New Ser., xvii, 1882, p. 570.)—W. G. Smith observed flowers of this species in which flies had been caught by the legs.

575. Stephanotis Thou.

The corolla-tube is long, so that only nocturnal Lepidoptera can effect pollination. The clips attach themselves to the proboscis (Delpino, op. cit.).

576. Ceropegia L.

1886. C. elegans Wall. (Delpino, 'Ult. oss.,' pp. 224–8; Hildebrand, Bot. Ztg., xxviii, 1870, pp. 604–5.)—In this species the visitors are small flies (e.g. Gymnopa opaca *Rond.*), which when they settle on the flower are held fast for a day by means of stiff hairs. These then become limp and allow the flies to escape with clips holding on to their proboscis. Pollination is now effected of fresh flowers which may be visited.

Visitors.—*Vide supra.*

577. Periploca Tourn.

1887. P. graeca L. (Delpino, 'Sugli appar. d. fecondaz. nelle piante autocarp.,' pp. 14–15; Hildebrand, Bot. Ztg., Leipzig, xxv, 1867, p. 273.)—The flower mechanism of this species deviates from that of other Asclepiads. The five spoon-shaped bands (retinacula) are sunk in the five angles of the stigmatic disk in the direction of the long axis of the flower. The broadened part of each band lies under two loculi belonging to adjacent anthers, and becomes covered with a sticky mass shortly before the flower opens, taking up pollen when dehiscence takes place. When a fly visits a flower its proboscis sticks to the adhesive matter present on the stalk of the spoon, and this is carried off with the pollen to be transferred to the stigma of another flower.

LXVIII. ORDER *GENTIANEAE* JUSS.

Flowers homogamous, protandrous, or protogynous; usually possessing a large, brightly coloured corolla. Some species are generally dimorphous (Menyanthes trifoliata *L.*, Limnanthemum nymphoides *Hoffm. et Link*, Erythraea Centaurium *Pers.*). The species of the genera Erythraea and Chlora appear to secrete no nectar; in other cases there is nectar, which is either accessible to all (Gentiana lutea *L.*), or else concealed, in many cases so deeply that only humble-bees or Lepidoptera can reach it. The genera and species which have been investigated belong to the following flower classes.—

Po (?): Erythraea, Chlora;

E: Gentiana lutea *L.*;

C: Menyanthes, Limnanthemum, Swertia;

Hh: Gentiana punctata *L.*, G. acaulis *L.*, G. asclepiadea *L.*, G. ciliata *L.*, G. purpurea *L.*, G. Amarella *L.*;

HhL: Gentiana tenella *Rott.*, G. nana *Wulf.*, G. campestris *L.*, G. obtusifolia *Willd.*, G. aurea *L.*;

Lb: Gentiana nivalis *L.*;

Lbdh-m (dh-m=diurnal hawk-moths): Gentiana verna *L.*, G. bavarica *L.*

578. Menyanthes Tourn.

Flowers mostly dimorphous, with concealed nectar secreted at the base of the ovary.

1888. M. trifoliata L. (Sprengel, 'Entd. Geh.,' pp. 102–3; Warming, 'Bestövningsmaade,' pp. 13–15; Heinsius, Bot. Jaarb. Dodonaea, Ghent, iv, 1892, p. 71; MacLeod, op. cit., v, 1893, p. 383; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. I, II, pp. 310–11; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 104–5.)—The flesh-coloured flowers of this species are arranged in racemes, and are remarkable on account of the

FIG. 258. *Menyanthes trifoliata*, *L.* (from nature). (1) Short-styled flower, after removal of a petal and a stamen (natural size). (2) Long-styled do. (natural size). (3) Stigmatic papillae of long style (× 4). (4) Do. of short style (× 4). (5) Pollen-grain of a long stamen (× 70). (6) Do. of a short stamen (× 70).

fringed limbs of the petals. These not only enhance conspicuousness, but protect the nectar against rain and unbidden guests. Only the long-styled form was seen and depicted by Sprengel. The plant is not heterostylous everywhere, for Warming describes it as homostylous in West Greenland, between 61° and 69° N. lat. The anthers and stigma are at the same level, or the latter a little higher. Automatic self-pollination is therefore easily possible. (*Cf.* Fig. 259.)

Warnstorf found the long-styled form at Ruppin, with stamens of the same length, when the flowers opened, so that stigma and anthers were at the same level, thus facilitating autogamy. The pollen is of a beautiful orange-yellow colour in bulk: the individual grains are spheroidal to ovoid, and marked with closely approximated, very delicate streaks, parallel to a large extent, and gradually disappearing towards the poles. Curiously enough the cell-walls of the hairs on the inner surface of the limbs of the petals exhibit similar, but feebler streaks. Heinsius has measured the ovoid pollen-grains. Those of the long-styled form are on the

average 26 μ long and 50 μ broad, while those of the short-styled form are 120 μ long and 63 μ broad.

In the short-styled flowers I have examined at Kiel the stigma is situated in the throat of the corolla, while in long-styled ones it projects several millimetres from this. The anthers diverge in a swallow-tailed fashion, and their height is of course inversely proportional to that of the stigma. Their pollen-covered surfaces are directed inwards. Heinsius describes the extremely long stigmatic papillae of the two forms as pretty much the same, but it seems to me that there is a difference in size approximately proportional to that of the two kinds of pollen-grain. He also states that though plants of the same kind are associated in groups, legitimate crossing is frequent as indicated by the size of the pollen-grains adhering to the stigmas.

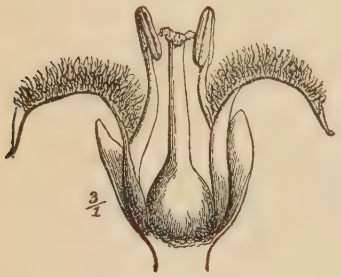


FIG. 259. *Menyanthes trifoliata, L.* (after Warming). An isostylous flower from Julianshaab, in Greenland, in longitudinal section (× 3).

Kerner and Warnstorf say that the flowers are not only dimorphous, but also feebly protogynous. According to the former, automatic self-pollination can take place pseudo-cleistogamously in the closed flowers.

VISITORS.—Sprengel observed humble-bees, corresponding in size to the flowers. At Kiel I have only seen the beetle Meligethes, while Warnstorf only noticed small beetles and flies at Ruppin. Heinsius saw the butterfly Pieris rapae *L.*, skg., in Holland. In Dumfriesshire Apis and a humble-bee have been recorded (Scott-Elliot, 'Flora of Dumfriesshire,' p. 119).

579. **Limnanthemum** S. P. Gmel.

Flowers dimorphous, with concealed nectar, secreted at five places between the roots of the filaments.

1889. L. nymphoides Hoffmgg. et Link (=Menyanthes nymphoides *L.*, and Villarsia nymphoides *Vent.*). (Kuhn, Bot. Ztg., Leipzig, xxv, 1867, p. 67; Heinsius, Bot. Jaarb. Dodonaea, Ghent, iv, 1892, pp. 72–6; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 171.)—Kerner states that as the flowers of this species wither the petals become pulpy, the cell-sap exuding to form a thin surface layer which is particularly attractive to flies. These visitors effect cross-pollination. Heinsius describes the large, bright yellow, stellate corolla as possessing fringe-like appendages on the boundary between its tube and limb. These are directed obliquely upwards and extend to the ovary, completely closing the entrance of the flower. The long style is of the same breadth as the short one, but about half as long again. The proportion is 28 : 20, while the relative length of the corresponding stamens is 20 : 27. The bluntly triangular pollen-grains are about 24–37 μ in diameter in the long-styled form, and 43–6 μ in the short-styled one.

The flower-buds are submerged, raising themselves above the surface before they open. When anthesis is over, the peduncle bends again, and the fruit ripens under water. Heinsius often found pollen-grains from the opposite form on the stigma, a proof that legitimate union takes place.

Visitors.—Heinsius observed the following.—

The bee Apis mellifica *L.* ☿, touching the anthers of the short stamens and the stigma of the short style with its thorax, and the corresponding parts of the long-styled form with its abdomen, 2 humble-bees (apparently Bombus agrorum *F.*, and B. scrimshiranus *K.*), 2 hover-flies (Platycheirus peltatus *Mg.* ♂, and Helophilus lunulatus *Mg.* ♀), and 2 Muscids (Anthomyia pratensis *Mg.* ♂, and A. sp. ♂).

1890. L. Humboldtianum. (Fritz Müller, Bot. Ztg., Leipzig, xxvi, 1868, p. 13.)—Fritz Müller describes this species as dimorphous, like L. nymphoides.

580. Chlora L.

Flowers devoid of nectar; arranged in sub-corymbose cymes.

1891. C. perfoliata L. (=G. perfoliata *L.*). (Vaucher, 'Hist. physiol. des pl. d'Europe,' III, p. 404.)—Vaucher says that the yellow flowers of this species close at night. The corolla-tube is closely approximated to the ovary. The two bilobed, thickened, papillose stigmas are self-pollinated.

581. Swertia L.

Flowers more or less protandrous; with nectar secreted by minute cups surrounded by interwoven fringes, and situated in pairs at the bases of the petals, one pair to each.

1892. S. perennis L. (Schulz, 'Beiträge'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 241, 341; Francke, 'Beiträge.')—In the flowers of this species the corolla varies from steel-blue through grey-white to bright yellow in colour, and the petals are marked by numerous streaks. Schulz says that now and then the pistil or some of the stamens may be reduced, but complete gynodioecism or androdioecism is rare. The anthers of hermaphrodite flowers dehisce a longer or shorter time after the maturation of the stigma. Francke and Schulz state that the stamens are bent back so much that self-pollination is excluded. Kerner, however, observed that autogamy finally takes place, for before all the pollen is shed the stamens first straighten and then move towards and pollinate the stigma. But, on the other hand, Francke and Schulz assert that such autogamy is exceptional, for as a rule no pollen remains on the anthers by the time they reach the stigma.

Visitors.—Schulz observed small flies and beetles in the Riesengebirge.

1893. S. punctata Baumg.—This species is native to Hungary and the Siebengebirge, and Kerner states that its flower mechanism is the same as that of S. perennis.

582. Gentiana Tourn.

Flowers blue, rarely red or yellow in colour; nectar as a rule so deeply concealed that only humble-bees or Lepidoptera can get at it, but exposed in rare cases (*cf.* pp. 96–7). Hermann Müller divides the species into five groups, according to the position and mode of secretion of the nectar ('Alpenblumen,' pp. 329–49).—

1. Species with exposed, freely accessible nectar: Gentiana lutea *L.*

2. Species with nectar secreted by the base of the ovary, and a bell-shaped corolla adapted to humble-bees (humble-bee flowers; sub-genus Coelanthe): G. purpurea *L.*, G. pannonica *Scop.*, *G. punctata *L.*, G. cruciata *L.*, *G. asclepiadea *L.*, G. Pneumonanthe *L.*, G. Froelichii *Jan.*, G. frigida *Haenke*, G. acaulis *L.*

3. Species with nectar secreted by the base of the ovary, and with the broad disk-shaped stigma so closely surrounded by the long tubular corolla that only long-tongued Lepidoptera can suck conveniently (Lepidopterid flowers; sub-genus Cyclostigma): *G. bavarica *L.*, *G. verna *L.*, G. imbricata *Froel.*, G. pumila *Jacq.*, G. utriculosa *L.*, *G. nivalis *L.*

4. Flowers adapted to pollination by humble-bees, and with nectar secreted by the lowest part of the corolla (humble-bee flowers; sub-genus Crossopetalum); *G. ciliata.

5. Species adapted to pollination by humble-bees and Lepidoptera, and with nectar secreted as in 4 (humble-bee and Lepidopterid flowers; sub-genus Endotricha); *G. campestris *L.*, G. germanica *Willd.*, G. Amarella *L.*, *G. obtusifolia *Willd.*, *G. tenella *Rottb.*, *G. nana *Wulf.*

FIG. 260. *Gentiana lutea*, *L.* (from Herm. Müller's 'Alpenblumen'). *A*. Oblique view of fully expanded flower. *B*. Bases of the pistil and two stamens. *a*, anther; *fi*, filament; *n*, nectary; *ov*, ovary; *p*, petal; *s*, sepal; *st*, stigma.

The species in the above list to which an asterisk (*) is prefixed have been described in a masterly way by Hermann Müller in his 'Alpenblumen.' I would refer the student to his accounts, and in what follows add some of Müller's earlier observations, as well as those of other investigators.

Kerner applies the term 'revolver flowers' to the blossoms of many species (e.g. G. acaulis *L.*, G. angustifolia *Michx.*, and G. Clusii *Perr. et Song.*) on account of their narrow tubular nectar-passages. (*Cf.* the note on Convolvulus.)

1894. G. lutea L. (Herm. Müller, 'Alpenblumen,' pp. 329–30.)—The yellow homogamous flowers of this species secrete exposed nectar, and automatic self-pollination is possible.

VISITORS.—Herm. Müller observed 3 beetles, 14 flies, 6 Hymenoptera, and 2 Lepidoptera.

1895. G. punctata L. (Herm. Müller, op. cit., pp. 330–2.)—This species bears protogynous humble-bee flowers, yellow in colour, with black punctations. Automatic self-pollination is generally excluded. Kerner describes the flowers as protandrous.

VISITORS.—Herm. Müller observed 2 beetles, 2 flies, 7 Hymenoptera (including 5 humble-bees), and 3 Lepidoptera. Crossing is effected by humble-bees only.

1896. G. purpurea L. (Kirchner, 'Beiträge,' pp. 47–9.)—Kirchner says that the flower mechanism of this species agrees essentially with that of G. punctata, the blossoms being feebly protogynous humble-bee flowers. They are strongly

aromatic, directed obliquely or vertically upwards, externally bright or dark purple in colour, and of whitish-yellow towards their bases both externally and internally. Longitudinal green veins on the inner surface serve as nectar-guides. The club-shaped corolla is thrown into internal longitudinal folds, and its length is 35 mm., of which 10 mm. are taken up by the six lobes. The filaments are free down to the place where the corolla narrows, but below this are fused with the longitudinal folds, to constitute high ridges extending to the ovary and leaving five narrow tubular nectar-passages. There are six green nectaries at the base of the ovary, between the bases of the filaments. The anthers are completely fused together and dehisce extrorsely. They surround the style, and the two stigmas project beyond them and mature somewhat earlier. Although the stigmas roll up later on into spirals of more than one turn, they do not come into contact with the anthers, and automatic self-pollination does not therefore take place.

Visitors.—The size and structure of the flowers would indicate humble-bees as the pollinators, but Kirchner never saw them at Zermatt, though he observed numerous flies, which flew about inside the blossoms, and occasionally touched the anthers and stigmas.

1897. G. pannonica Scop.—Kerner describes this species as protandrous.

1898. G. cruciata L.—Kerner says that the protandrous flowers of this species open 8–9 a.m. and close again 7–8 p.m.

Visitors.—Schulz observed flowers perforated by humble-bees in Central Germany.

1899. G. asclepiadea L. (Herm. Müller, 'Alpenblumen,' pp. 356–7; Delpino, 'Ult. oss.,' pp. 166–7; Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870, pp. 668–9.)—This species bears protandrous humble-bee flowers, in which automatic self-pollination is generally excluded. Hermann Müller did not observe the true pollinators, but only Bombus mastrucatus perforating the flowers, and stealing the nectar. He convinced himself that the opening of the flowers is not dependent upon the action of light, but of warmth, for he picked a bunch of closed flowers and placed them in a dark, but warm room, where they began to open in 25 minutes. Kerner, on the contrary, believes that opening (which takes place 8–9 a. m.) is brought about by the stimulus of light. According to him self-pollination takes place when the corolla closes, in the same way as in the next species.

Visitors.—*Vide supra*. Hoffer (Steiermark) observed 2 humble-bees—Bombus gerstaeckeri *Mor.* ☿, po-cltg., and B. latreillellus *K.* ♀, skg.

1900. G. Pneumonanthe L. (Sprengel, 'Entd. Geh.,' pp. 150–2; Warming, 'Arkt. Växt. Biol.,' p. 10; Herm. Müller, 'Fertilisation,' pp. 403–4; Schulz, 'Beiträge'; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 381–2; Kirchner, 'Flora v. Stuttgart,' p. 540; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 373; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 105, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 238.)—This species bears protandrous humble-bee flowers. The large deep-blue corolla is marked externally with five green streaks, and is 30 mm. long with an entrance 8–10 mm. broad. Nectar is secreted by the base of the ovary, and is

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protected from rain by closure of the corolla during dull weather. This also takes place at night. The inner side of the corolla possesses nectar-guides in the form of small whitish circles with brownish centres, from which alternating blue and whitish longitudinal streaks turn to the base of the flower. At about its middle the corolla-tube suddenly contracts, and from this point downwards it, and the filaments fused with it, closely surround the ovary. Humble-bees can creep half-way into the flowers, dusting themselves in younger ones from the dehisced anthers which closely surround the still immature stigmas. In older flowers the style has elongated and its stigmatic branches have become bent back so that their papillose inner surfaces will be touched by those parts of humble-bee visitors which have taken up pollen. The arrangements, in fact, are such that insects of a size proportionate to the interior of the flower inevitably effect crossing. Kerner states that automatic self-pollination is possible in later stages of anthesis, for when the flower closes some of the pollen still clinging to the anthers is transferred to the internally projecting folds of the corolla, and is subsequently raised to the level of the stigma by elongation of the corolla-tube. Closure will then effect autogamy.

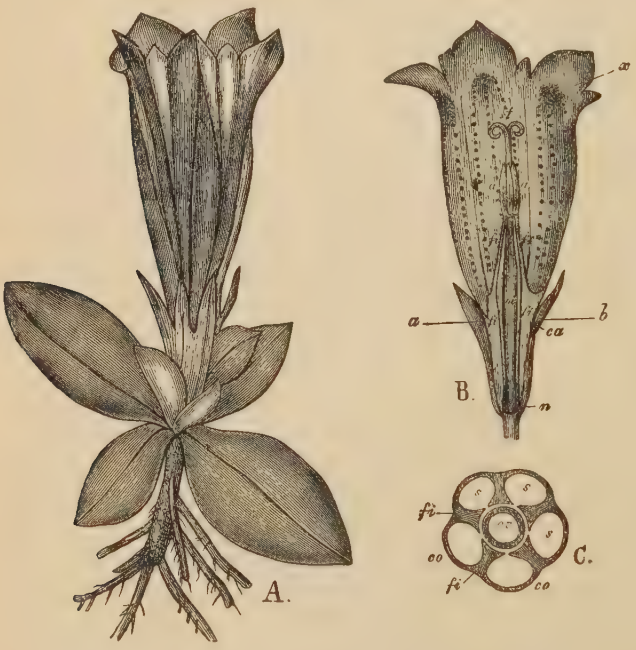


FIG. 261. *Gentiana acaulis*, *L.* (from Herm. Müller's 'Alpenblumen'). *A.* Entire plant. *B.* Longitudinal section of flower. *C.* Cross-section through base of do. (on the line *ab*). *a*, anthers; *ca*, calyx; *co*, corolla; *fi*, filaments; *n*, nectary; *ov*, ovary; *s*, nectar-passages; *st*, stigma *x*, upper end of nectar-guides.

Warnstorf describes the pollen-grains as yellowish in colour, ellipsoidal, with a groove, delicately papillose, striated, on the average 50 μ long and 25 μ broad.

VISITORS.—E. Möller sent me the following from Sylt, of which only Nos. 1, 2, and 5 were able to get at the nectar ('Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 238).—

A. Hymenoptera. *Apidae*: 1. Bombus cognatus *Steph.* ♀ and ♂, skg.; 2. B. derhamellus *K.* ♀, do.; 3. B. terrester *L.*, stealing nectar (up to beginning of October 1893); 4. Apis mellifica *L.* ☿, do.; 5. Psithyrus vestalis *Fourcr.* ♂, skg. **B. Diptera.** All only po-dvg. (*a*) *Syrphidae*: 6. Platycheirus scutatus *Mg.* ♀; 7. P. manicatus *Mg.* ♀. (*b*) *Muscidae*: 8. Aricia incana *Wied.* ♀; 9. Anthomyia sp.; 10. Pollenia rudis *F.*

The following were recorded by the observers, and for the localities stated.—

Herm. Müller, 2 humble-bees—Bombus agrorum *F.* ♀ (proboscis 12–15 mm.) and B. muscorum *F.* ♀ (proboscis 11–15 mm.), both freq., skg., Schulz (Halle), numerous flowers perforated by humble-bees. Kerner, small beetles using the flowers as a refuge. Alfken (Bremen), the bee Halictus flavipes *F.* ♀, po-cltg. H. de Vries (Netherlands), the humble-bee Bombus agrorum *F.* ☿.

1901. G. acaulis L. (Herm. Müller, 'Alpenblumen,' pp. 332–6; Ricca, Atti Soc. ital. sc. nat., Milano, xiv, 1871; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 163, 198, including G. excisa *Presl.*)—This species bears protandrous odourless humble-bee flowers ('revolver flowers' of Kerner), in which self-pollination is usually excluded. Kerner says that they become pendulous in unfavourable weather, so that pollen which falls out of the anthers is guided to the stigma along the furrows between the folds of the corolla, thus effecting automatic self-pollination. According to Hermann Müller, opening and closing are not dependent upon increase and decrease of light, but of heat. Kerner states that the flowers open about 7–8 a. m., shutting again about 6–7 p. m.

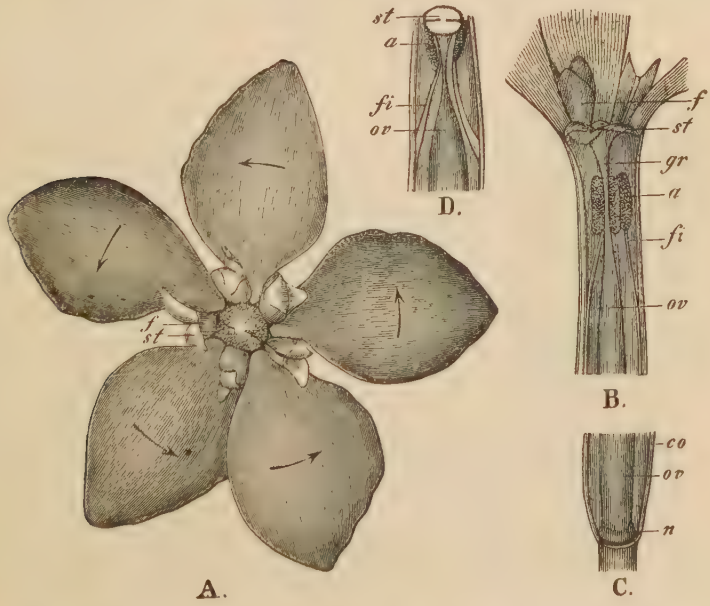


FIG. 262. *Gentiana verna*, *L.* (from Herm. Müller's 'Alpenblumen'). *A.* Flower seen directly from above. *B*, *C.* Upper and lower parts of longitudinal section of flower. *D.* Similar section through upper part of flower, with anthers at a higher level than in *B*. *a*, anthers; *co*, corolla; *f*, ligules; *fi*, filaments; *gr*, style; *n*, nectary; *ov*, ovary; *st*, stigma.

VISITORS.—The following were recorded by the observers stated.—

Herm. Müller, 8 bees (including 5 humble-bees), 3 Lepidoptera, a fly, and a beetle, though only the humble-bees are effective pollinators. Ricca, humble-bees effecting pollination. Herm. Müller found 90 % of the flowers perforated by Bombus mastrucatus *Gerst.* Kerner saw small beetles using the flowers as a refuge.

1902. G. angustifolia Michx., and **1903. G. Clusii** Perr. et Song. (= G. acaulis *L.*, according to the *Index Kewensis*).—These species both bear 'revolver flowers' in which, according to Kerner, autogamy can take place as in G. acaulis.

1904. G. Froelichii Jan.—Kerner states that this species bears protandrous humble-bee flowers.

1905. G. bavarica L. (Herm. Müller, 'Alpenblumen,' pp. 341–2; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 181–2, 209, 219, 282, 311.)—This species bears homogamous (according to Kerner protogynous) odourless Lepidopterid flowers, with nectar concealed at a depth of 20–2 mm. Visitors can effect self- as well as cross-pollination, but foreign pollen is prepotent. Kerner says that the flowers open very quickly, and that only the edge of the stigma is papillose.

Visitors.—The most frequent pollinator observed by Herm. Müller was the diurnal hawk-moth Macroglossa stellatarum *L.* (proboscis 25–8 mm. long) visiting hundreds of flowers in a few minutes.

1906. G. verna L. (Herm. Müller, op. cit., pp. 340–1; Kerner, op. cit., pp. 198, 209, 311; Delpino, 'Ult. oss.,' p. 168; MacLeod, 'Pyreneënbl.')—This species bears homogamous (according to Kerner protogynous) Lepidopterid flowers, with nectar concealed at a depth of 23 mm. Their mechanism agrees with that of G. bavarica. Kerner says that the flowers open very quickly.

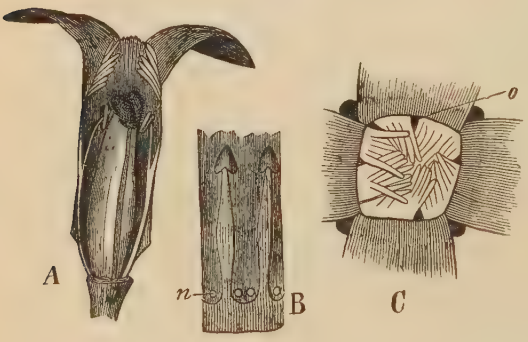


Fig. 263. *Gentiana tenella*, *Rottb.* (from Herm. Müller's 'Alpenblumen'). *A*. Flower partly dissected from the side. *B*. Part of the corolla-tube, seen from inside. *C*. Opening of corolla-tube, from above. *n*, nectary; *o*, a nectar-passage.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps) and MacLeod (Pyrenees), the diurnal hawk-moth Macroglossa stellatarum *L.*, as the actual pollinator. Hoffer (Steiermark), the humble-bee Bombus mastrucatus *Gerst.* ♀.

1907. G. prostrata Haenke. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 391.)—Kerner states that in the protandrous flowers of this species nectar is secreted at the base of the ovary. In unfavourable weather automatic self-pollination takes place pseudo-cleistogamously in the closed flowers.

1908. G. utriculosa L.—Kerner states that the flowers of this species open about 8–9 a. m. and close again about 3–4 p. m.

1909. G. nivalis L. (Herm. Müller, 'Alpenblumen,' pp. 342–3; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 116, 220; Warming, 'Arkt. Växt. Biol.,' pp. 8–9; Lindman, 'Bidrag till Känned. om Fjellväxt. Blomn. o. Befrukt.')—This species bears homogamous Lepidopterid flowers. Their conspicuousness is small, and Hermann Müller saw no lepidopterous visitors capable of getting at the nectar. Automatic self-pollination is easily possible, for the anthers apply themselves to the stigma. In this respect Warming and Lindman state that flowers from Greenland and the Dovrefjeld agree with those from the Alps, and Warming even frequently

observed the anthers and stigma bound together by pollen-tubes. Kerner states that the flowers open and close several times in the course of an hour.

1910. G. tenella Rottb. (=G. glacialis *Vill.*). (Herm. Müller, op. cit., p. 345; Kirchner, 'Beiträge,' p. 49; Warming, 'Arkt. Växt. Biol.,' p. 9.)—This species bears feebly protogynous (according to Kirchner homogamous) humble-bee and Lepidopterid flowers, in which automatic self-pollination regularly takes place towards the end of anthesis. Kerner says that it may be effected pseudo-cleistogamously in unfavourable weather, when the flowers remain closed. He adds that the fringes of the valves projecting from the throat of the corolla-tube are beset with minute prickles, which prevent insects from inserting their proboscis except into the nectar-passages. Warming describes autogamy for plants from the Dovrefjeld.

1911. G. nana Wulf. (=G. tenella *Rottb.*, according to the *Index Kewensis*). (Herm. Müller, op. cit., pp. 345–6; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 248.)—This species bears homogamous humble-bee and Lepidopterid flowers, in which automatic self-pollination regularly takes place towards the end of anthesis. Kerner describes the fringed valves of the throat of the corolla-tube as corresponding to those of G. tenella.

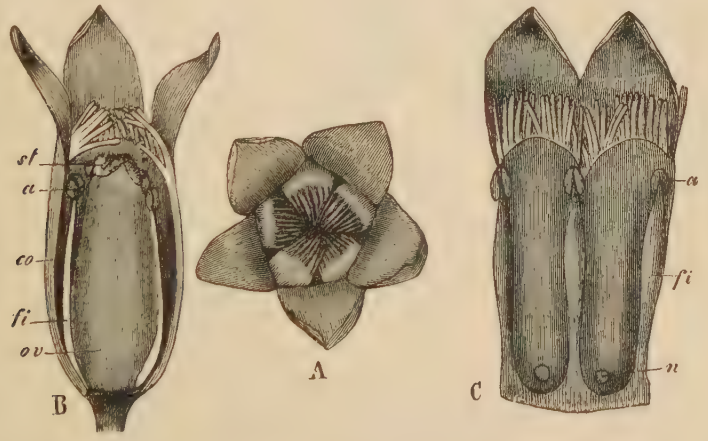


FIG. 264. *Gentiana nana*, *Wulf.* (from Herm. Müller's 'Alpenblumen'). *A*. Flower seen directly from above. *B*. Do., partly dissected from the side. *C*. Part of corolla, seen from within. *a*, anthers; *co*, corolla; *fi*, filaments; *n*, nectary; *ov*, ovary; *st*, stigma.

1912. G. aurea L. (=G. involucrata *Rottb.*). (Warming, 'Arkt. Växt. Biol.,' pp. 10–12.)—This species bears humble-bee and Lepidopterid flowers. Warming describes it as protandrous in Finmark and at Tromsø, though automatic self-pollination takes place in the second stage of anthesis by contact of the anthers (to which some pollen still clings) with the stigma.

1913. G. detorsa Rottb. (=G. serrata *Gunner*).—Aurivillius says that in Greenland the flowers of this species are adapted to Lepidoptera, and perhaps also to humble-bees.

1914. G. campestris L. (Herm. Müller, 'Alpenblumen,' pp. 346–8; Schulz, 'Beiträge,' II, pp. 107, 214; Lindman, 'Bidrag till Känned. om skandin. Fjellväxt.

Blomn. o. Befrukt.'; Warming, 'Arkt. Växt. Biol.,' p. 12; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 366, 391; Warnstorf, Verh. bot. Ver., Berlin, xxxvii, 1896.)—This species bears humble-bee Lepidopterid flowers. Hermann Müller (canton Graubünden), Lindman (Norway), and Warming (Iceland) describe it as feebly protogynous, afterwards becoming homogamous, while Schulz (Westphalia and Thuringia) observed it to be strongly protandrous. In all cases automatic self-pollination is possible in the later part of anthesis. Kerner says that this autogamy is brought about by gradual elongation of the corolla, so that the anthers of the epipetalous stamens are brought into contact with the stigma; and that during unfavourable weather it may take place pseudo-cleistogamously in the closed flowers. The flowers of plants from higher stations in Norway are of relatively large size, and the stigma is not above the anthers but at the same level or even lower, so that self-pollination is facilitated. It is otherwise in flowers from the Alps, for here the stigma at first projects beyond the anthers, and it is only in late anthesis that the stylar branches bend back far enough, according to Hermann Müller, to effect autogamy. Schulz, on the other hand, says that this takes place very infrequently.

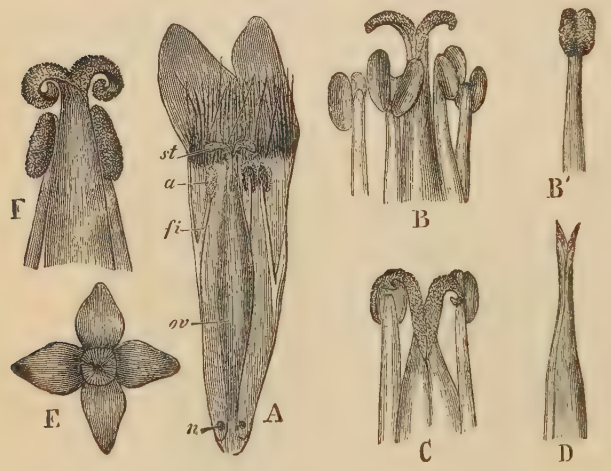


FIG. 265. *Gentiana campestris*, *L.* (from Herm. Müller's 'Alpenblumen'). *A*. Flower partly dissected from the side. *B*, *C*, *F*. Relations of stigmas and anthers at different stages. *B*. Stamen with dehiscing anther. *D*. Old pistil. *E*. Flower seen directly from above. *a*, anthers *fi*, filaments; *n*, nectaries; *ov*, ovary; *st*, stigma.

Warnstorf describes the pollen-grains as yellowish in colour, ellipsoidal, traversed by several longitudinal furrows, densely papillose, on the average 63 μ long and 37·5 μ broad.

VISITORS.—The following were recorded by the observers stated.—

Lindman, humble-bees. Herm. Müller, humble-bees and Lepidoptera, and also perforations made by Bombus mastrucatus *Gerst.* Schulz (Central Germany), humble-bees and Lepidoptera, and flowers perforated by the former.

1915. G. Amarella L. (Herm. Müller, 'Fertilisation,' p. 404; Warming, 'Arkt. Växt. Biol.,' p. 12; Schulz, 'Beiträge.')—This species bears homogamous humble-bee flowers. The corolla-tube is 16–18 mm. long with an entrance 6 mm. wide, into which a humble-bee can easily thrust its head, so that a proboscis 10–12 mm. in length suffices to reach the nectar. This is secreted in the base of the flower by five fleshy green spots alternating with the filaments. There are long inwardly directed hairs at the junction between the tube and limb of the corolla, serving as a protection against unbidden guests (flies), and the nectar is sheltered from rain by closure of the corolla in dull weather.

The anthers dehisce when the flower opens, their pollen-covered surfaces being directed upwards, so that if the head of a humble-bee is thrust into the corolla-tube it must touch them. The two stigmas simultaneously diverge, and as they project beyond the anthers cross-pollination is favoured, though autogamy is not excluded.

In plants from the Dovrefjeld and Nordland, according to Lindman and Warming respectively, automatic self-pollination is easily possible, for the anthers generally touch the stigma.

Warnstorf describes the pollen-grains as whitish in colour, ellipsoidal, densely papillose, about 56 μ long and 44 μ broad.

Visitors.—Herm. Müller observed a humble-bee (Bombus sylvarum *L.*, with a proboscis of 12–14 mm.), skg.

1916. G. germanica Willd. (Ricca, Atti Soc. ital. sc. nat., Milano, xiii, 1870; Schulz, 'Beiträge'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 302, 311.)—The large flowers of this species attain an average length of 28–32 mm., and are violet in colour, often with a whitish tube; rarely pure white, and still more rarely yellow. They are heterostylous humble-bee Lepidopterid flowers, described by Schulz as feebly or strongly protandrous, by Kerner as protogynous. The nectaries are situated as in G. Amarella. Schulz states that the anthers are at first directed inwards, but gradually twist themselves round till they face outwards. In the homogamous or feebly protandrous flowers automatic self-pollination is possible, owing to the stigma and anthers being at the same level, but the outwardly directed position of the latter renders it difficult. The flowers are homogamous in the Alps, but the stigma is at a higher level than the anthers, so that autogamy is impossible.

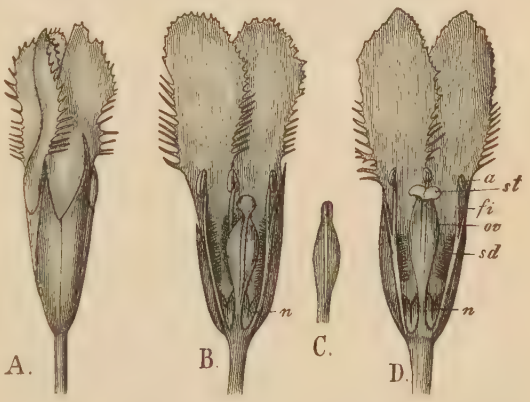


Fig. 266. *Gentiana ciliata*, *L.* (from Herm. Müller's 'Alpenblumen'). *A.* Exterior of flower, seen from the side, in first (male) stage. *B.* Do., partly dissected. *C.* Pistil of same. *D.* Flower in second (female) stage, partly dissected from the side. *a*, anthers; *fi*, filaments; *n*, nectary; *ov*, ovary; *sd*, nectar-cover; *st*, stigma.

Kerner describes the Alpine sub-species G. rhaetica *Kerner* as being heterostylous and protogynous.

Visitors.— Ricca observed the honey-bee and humble-bees; Schulz noticed flowers perforated by the latter.

1917. G. obtusifolia Willd. (Herm. Müller, 'Alpenblumen,' p. 348; Schulz, 'Beiträge.')—This species bears protandrous humble-bee Lepidopterid flowers, which Schulz describes as gynomonoecious. As a rule the style projects beyond the anthers down to the point where it bifurcates. There are, however, some flowers with shorter styles, the branches of which roll back and take up the pollen still clinging to the anthers, thus effecting automatic self-pollination.

Visitors.—Herm. Müller observed 3 humble-bees (including Bombus mastrucatus *Gerst.*, and B. terrester *L.*, obtaining nectar by perforating the flowers), and a Lepidopterid.

1918. G. ciliata L. (Herm. Müller, op. cit., pp. 343–4; Delpino, 'Ult. oss.,' pp. 166–7; Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870, pp. 668–9; Schulz, 'Beiträge'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 163, 300, 311.)—This species bears protandrous humble-bee flowers which smell like violets. Schulz states that they are sometimes homogamous, and Kerner describes them as trimonoecious. The anthers are at first directed inwards, but dehisce extrorsely in the first stage of anthesis and cover their outer sides with pollen. They are usually empty when the stigmatic lobes expand, and automatic self-pollination consequently only takes place occasionally. Nectar is secreted by five elongated raised patches of a shining green colour at the base of the corolla, and bees or Lepidoptera probing for this must regularly effect cross-pollination.

Visitors.—Schulz observed bees, more rarely Lepidoptera. Herm. Müller and Schulz noticed flowers perforated by humble-bees. Kerner says that the flowers serve as a refuge to small beetles.

583. Erythraea Rich.

Flowers usually rose-red, rarely white in colour; homogamous, more rarely feebly protandrous or protogynous; nectarless, but possessing succulent basal tissue which insect visitors bore[1]. Heterostyly frequent.

1919. E. Centaurium Pers. (=Gentiana Centaurium *L.*). (Sprengel, 'Entd. Geh.,' p. 152; Herm. Müller, 'Fertilisation,' p. 407, 'Weit. Beob.,' III, p. 61; Kirchner, 'Flora v. Stuttgart,' p. 543, 'Neue Beob.,' p. 63; Schulz, 'Beiträge,' I, p. 71; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 213; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 382–3; A. Stephen Wilson, Rep. Brit. Ass., London, 1878, p. 568; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 105–6, 164.)—The plants of this species examined by me in the North Frisian Islands were homogamous. The stigmas are mature when the flower opens, at which time the anthers dehisce successively, but autogamy is at first prevented by bending of the style to one side, and the stamens, as their anthers dehisce, to the opposite side. Later on the stamens raise themselves to a height of 4 mm., and the somewhat shorter style also becomes erect, so that the anthers with some pollen still adherent are brought above the stigma, and automatic self-pollination results from the fall of pollen. Autogamy may also in many cases take place immediately after the flowers have opened, for not infrequently there is no lateral bending of style and stamens. During bad weather, and when the flowers begin to fade, this kind of pollination is inevitably brought about by convergence of the corolla-lobes. Wilson observed

[1] When flowers of Erythraea Centaurium were treated (17.8.'98) with Fehling's solution and orthonitrophenylpropionic acid, only the former caused a small amount of copper oxide to be precipitated in the base of the flower, while the latter gave no indigo reaction. Only a small amount of sap can therefore be present.

heterostyly in England and associated dimorphism of the pollen-grains, but I was not able to confirm this in the North Frisian Islands, nor could Schulz and Kirchner do so in Central and South Germany. The two latter investigators, however, found the style to vary in length in different stocks, and even, in rare cases, on the same one. In long-styled forms the stigma may be at the level of the anthers, though usually lower; in short-styled ones it is situated in the opening of the corolla-tube. Schulz observed feeble protandry as well as homogamy, and Townsend records protogyny for the variety E. capitata *Willd.*

The flowers close periodically, and Kerner states that anthesis lasts for five days. Schulz and Kirchner call attention to variations in their size. Hermann Müller is of opinion that the spiral twisting of the anthers (resembling the screw-like torsion of the styles in Dianthus Carthusianorum and its allies) is probably an adaptation to the slender proboscis of butterflies, and that despite the absence of nectar these insects bore for sap in the bases of the flowers with the sharp processes on the tip of that organ. Warnstorf states that the flowers open between 6 and 7 a.m., closing again between 12 noon and 1 p.m. He describes the pollen-grains as yellow in colour, ellipsoidal, opaque, densely tuberculate, up to 44 μ long and 23 μ broad.

Visitors.—Herm. Müller gives the following list for Thuringia (T.) and Westphalia.—

A. Diptera. *Empidae*: 1. Empis livida *L.*, skg. **B. Hymenoptera.** *Apidae*: 2. Andrena aestiva *Sm.* ♀, po-cltg.; 3. A. gwynana *K.* ♀, do.; 4. Halictus morio *F.* ♀, do. **C. Lepidoptera.** All boring the tissue at the base of the flowers. (*a*) *Noctuidae*: 5. Agrotis pronuba *L.*, in large numbers, persistently skg.; 6. Plusia gamma *L.*, do. (*b*) *Rhopalocera*: all skg.: 7. Hesperia lineola *O.*; 8. Lycaena damon *S.-V.*; 9. Melitaea athalia *Esp.*; 10. Pieris rapae *L.* (*c*) *Sphingidae*: 11. Macroglossa stellatarum *L.*, skg. (T.); 12. Zygaena carniolica *Scop.*, do.

The following were recorded by the observers, and for the localities stated.—

Knuth, the po-dvg. hover-fly Syrphus balteatus *Deg.* MacLeod (Flanders), the hover-fly Eristalis arbustorum *L.* (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 383). Handlirsch, the fossorial wasp Gorytes tumidus *Pz.* Scott-Elliot (Dumfriesshire), an Empid, a hover-fly, and 2 Muscids ('Flora of Dumfriesshire,' p. 118).

1920. E. linariifolia Pers. (Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 106.)—The flower mechanism of this species agrees with that of E. Centaurium, but the style does not bend away from the stamens to the same degree.

1921. E. ramosissima Pers. (= E. pulchella *Hornem.*). (Knuth, loc. cit.; Schulz, 'Beiträge;' Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 366.)—The flower mechanism agrees with that of E. linariifolia, and here again the divergence of the stigma from the anthers is not so marked as in E. Centaurium, but the stamens and style are almost always erect, so that, should insect-visits take place, cross- and self-pollination are equally possible, while the latter may also take place automatically. Schulz states that the short-styled form is particularly common in Central Germany. Kerner says that autogamy is effected by elongation of the corolla in the course of anthesis, the anthers being raised in this way to the level of the stigma. He adds that anthesis lasts for six days, and that the flowers open about 10–11 a.m., closing again 3–4 p.m.

584. Hockinia Gardn.

1922. H. montana Gardn. (Gilg, Ber. D. bot. Ges., Berlin, xiii, 1895.)—Gilg describes the flowers of this species as pleomorphous. Knoblauch (op. cit., xiii, 1895) refers all Gilg's forms to two only, so that it is only a case of dimorphism.

585. Halenia Borckh.

1923. H. Rothrockii A. Gray. (Gilg, op. cit.)—Gilg states that this species bears cleistogamous flowers of two kinds, in addition to the chasmogamous ones.

1924. H. multiflora Benth., and **1925. H. parviflora** G. Don (=Exadenus viridiflorus *Benth.*).—The relations are similar to those found in H. Rothrockii.

1926. H. elliptica D. Don; **1927. H. sibirica** Borckh.; **1928. H. Perrottetii** Griseb.; **1929. H. deflexa** Griseb.; **1930. H. Schiedeana** Griseb.; **1931. H. brevicornis** G. Don; and **1932. H. Pavoniana** G. Don. (=H. asclepiadea *Griseb.*).—Gilg (op. cit.) found cleistogamous flowers in all these species.

LXIX. ORDER *POLEMONIACEAE* LINDL.

Literature.—A. Peter, 'Polemoniaceae,' in Engler and Prantl's 'D. nat. Pflanzenfam.,' IV, 3 a, p. 43.

586. Polemonium L.

Flowers vary from class **C** to class **Hb**. Nectar secreted at the base of the ovary. Occasional gynomonoecism.

1933. P. caeruleum L. (Sprengel, 'Entd. Geh.,' p. 109; Axell, 'Om Anord. för Fanerog. Växt. Befrukt.,' p. 33; Herm. Müller, 'Alpenblumen,' pp. 257–9, 'Weit. Beob.,' III, pp. 8–9; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 175; Knuth, 'Bloemenbiol. Bijdragen.')—In this species about twenty blue or white flowers, 30 mm. or more in diameter, are borne in a terminal panicle, so that the plant is conspicuous from a distance. In garden plants examined by me at Kiel streaks in the base of the flower serve as nectar-guides, but these would not appear to be constant, for Hermann Müller only figures the whitish base of the corolla as serving this purpose in flowers cultivated at Lippstadt.

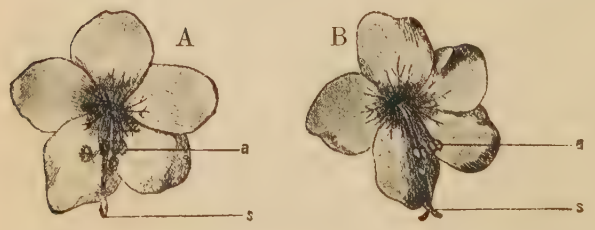


Fig. 267. *Polemonium caeruleum*, *L.* (from nature). *A.* Flower in the first (male) stage, seen directly from the front. *B.* Do., in the second (hermaphrodite) stage, seen as before. *a*, anthers; *s*, stigmas.

Nectar is secreted at the base of the ovary by a green, fleshy, annular swelling with a wavy edge. It is stored up in the corolla-tube (about 2 mm. deep), and this is closed by woolly hairs, so that only the more intelligent guests, such as

bees, can easily find the way to the nectar. After settling on a flower, a visitor clings to the exserted stamens and style. In the first stage of anthesis the anthers are ripe, while in the second the three stigmas project beyond the stamens and their papillose inner surfaces are first touched by insect visitors. It follows that crossing always takes place, while automatic self-pollination appears to be excluded. Kerner states, however, that later on the flower becomes pendulous and the stigmas are brought into the line of fall of the pollen. While all the flowers are hermaphrodite in the Alps, Hermann Müller also found some purely female ones in his garden at Lippstadt.

Ekstam describes the flowers in Nova Zemlia as dark blue in colour, smelling faintly of honey, and 30–5 mm. in diameter. They are protogynous or protogynous-homogamous, with a large amount of variation in the development of the reproductive organs.

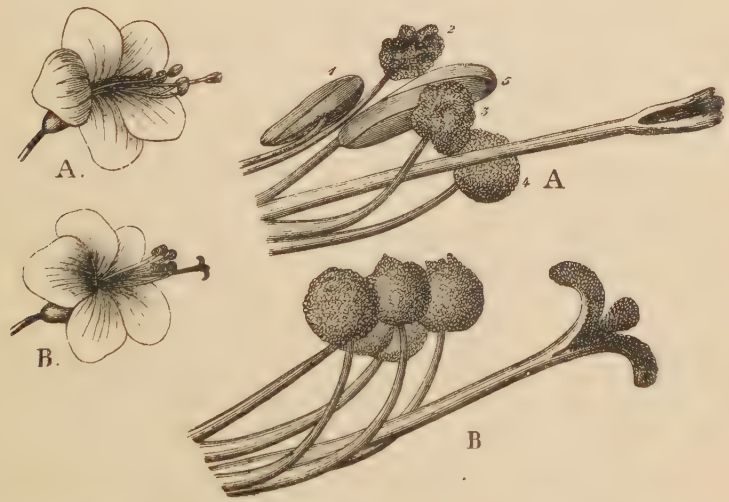


FIG. 268. *Polemonium caeruleum*, *L.* (after Herm. Müller). *A*. Flower in the first (male) stage. *A'*. Reproductive organs of do. (× 7). *B*. Flower in the second (hermaphrodite) stage. *B'*. Reproductive organs of do. (× 7). 1–5, anthers.

VISITORS.—Herm. Müller (H. M.) in Westphalia, and Buddeberg (Budd.) in Nassau, observed the following.—

A. Coleoptera. *Telephoridae*: 1. Dasytes flavipes *F.*, freq. in the flowers (H. M.). **B. Hymenoptera.** *Apidae*: all skg.: 2. Apis mellifica *L.* ☿ (H. M.); 3. Chelostoma campanularum *K.* ♂ (Budd.); 4. C. nigricorne *Nyl*, ♂ (Budd.); 5. Coelioxys sp. ♂ (H. M.); 6. Osmia rufa *L.* ♀, po-cltg. (Budd.), 27. 6. '73; 7. Megachile sp. ♀ (H. M.).

The following were recorded by the observers, and for the localities stated.—

Lindman (Dovrefjeld), a humble-bee. Herm. Müller (Alps), a beetle, 2 flies, the honey-bee, and 6 humble-bees. Knuth (on garden plants), the honey-bee, freq., skg. and po-cltg., its baskets thickly covered with orange-coloured pollen. It climbs up the style and stamens to the nectar, thus regularly effecting cross-pollination. The same remarks apply to three humble-bees—1. Bombus hortorum *L.* ☿; 2. B. lapidarius *L.* ♀; 3. B. terrester *L.* ♀. Schneider (on garden plants in Arctic

Norway), the humble-bees Bombus pratorum *L.* ☿, and B. terrester *L.* ☿ (Tromsø, Mus. Aarsheft., 1894).

1934. P. humile Willd. (=P. pulchellum *Bunge*). (Ekstam, 'Blütenbiol. Beob. a. Spitzbergen,' pp. 8–9, Bot. Jahrb., Leipzig, xxii, 1897, p. 185; Andersson and Hesselman, 'Bidrag till Känned. om Spetsbergens o. Beeren Eil. Kärlväxtflora,' pp. 17–18.)—Ekstam says that in Nova Zemlia this species exhales a strong and extremely unpleasant goat-like odour. The flowers are homogamous, and the nectar secreted in their bases is protected by glandular hairs lining the corolla-tube.

The plants observed in Spitzbergen by Andersson and Hesselman, also by Ekstam, bear blue or sometimes white flowers, which either possess a sweet smell suggesting that of Viola lutea, or a disagreeable musky one. At the opening of the corolla-tube there is an orange-yellow nectar-guide with a violet margin. There is a hypogynous annular nectary, the secretion of which is protected by long hairs on the bases of the filaments. The pollen-grains are normally developed, and rupture in a few minutes when placed in distilled water. The pollen is protected against damp partly by the position of the flowers, and partly by the facility with which the thin petals fall together during rain. Ekstam found marked protogyny in some cases, though homogamy is the general rule. The anthers are situated at a slightly higher level than the stigmas, so that autogamy is easily possible. The plant flowers in Spitzbergen from the end of June till the beginning of August, but in spite of this early anthesis fruits do not always ripen.

Visitors.—Ekstam observed medium-sized flies in Nova Zemlia, and also a hybrid P. humile *Willd.* × P. caerulem *L.*, indicating insect-visits. In this cross 90 % of the pollen-grains were abortive. No visitors were observed in Spitzbergen.

587. Phlox L.

Protandrous Lepidopterid flowers.

1935. P. paniculata L. (Sprengel, 'Entd. Geh.,' pp. 105–6; Herm. Müller, 'Fertilisation,' p. 407; Knuth, 'Bloemenbiol. Bijdragen,' 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 238.)—In this species nectar is secreted at the base of the ovary, and stored in the corolla-tube, which is 18–22 mm. long and 3 mm. broad at its centre. The dehisced anthers are situated in the entrance of the corolla-tube when the flower opens, and the still apposed stigmas about its centre. While the anthers are being robbed of their pollen, the style gradually elongates till it reaches their level, when the stigmas diverge and expose their papillose inner surfaces. Insect visitors will consequently transfer pollen from younger flowers to the stigmas of older ones.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (gardens at Nieblum, Föhr, 22. 7. '23), the diurnal hawk-moth visiting numerous flowers in succession; (his own garden at Kiel), the same moth. The form of the corolla-tube corresponds to that of the moth's proboscis, being slightly

bent. Sprengel, Lepidoptera. MacLeod, the moth Plusia gamma *L.*, skg. (Bot. Centralbl., Cassel, xxix, 1887). Herm. Müller, 2 Diptera—1. Conops flavipes *L.*, skg. (but scarcely reaching the nectar, its proboscis being only 4–5 mm. long); 2. Eristalis tenax *L.*, po-dvg. Schletterer and von Dalla Torre (Tyrol, two bees—1. Anthidium strigatum *Ltr.* ♀; 2. Halictus smeathmanellus *K.* ♀. Loew (Berlin Botanic Garden), the Muscid Echinomyia fera *L.*, as an unbidden guest.

1936. P. reptans Michx., and **1937. P. subulata** L.—

Visitors.—Loew observed the honey-bee in the Berlin Botanic Garden.—

1938. P. setacea L. (=P. subulata *L.*, according to the *Index Kewensis*). (Francke, Inaug. Dissert., Halle, 1883.)—Francke describes this species as protandrous. Self-pollination by the wind or by insects is possible.

588. Cobaea Cav.

1939. C. penduliflora Hook. f.—

Visitors.—A. Ernst states that this species is pollinated by hawk-moths (Kosmos, Leipzig, vii, 1880, pp. 44–6).

1940. C. scandens Cav. (W. J. Behrens, Flora, Marburg, New Ser., xxxviii, 1880, pp. 403–10; Knuth, 'Bloemenbiol. Bijdragen'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 304, 384–5.)—The flowers of this species observed by me in the Botanic Garden of the Kiel Ober-Realschule were greenish-white in colour when they opened, and therefore not very conspicuous. At first the anthers are not ripe nor the stigma mature. The lower corolla-lobes gradually assume a faint purple colour, but the whole flower does not become purple until the anthers dehisce. The breadth of the corolla seems to me much too considerable to make it probable that humble-bees are the pollinators of this plant in its native country, Mexico; and I think it far more likely that the larger humming-birds are the visitors.

Kerner describes the flower mechanism somewhat as follows.—At first the pollen-covered anthers are so disposed in the entrance of the flower that animals trying to secure the concealed nectar must brush against and remove the pollen. At this time the internal papillose surfaces of the three stigmas cannot be touched, for they are closely apposed, and concealed beneath the anthers owing to the shortness of the style. The filaments now elongate, so that the anthers are applied to the lower margin of the entrance of the flower, while the style curves upwards, and the stigmas diverge, taking up the position occupied by the anthers in the first stage of anthesis. Should there be no visits from pollinating animals, autogamy takes place as a last resort. The so far nodding flowers become pendulous, and the style and stamens curve more strongly, so that anthers and stigmas are brought into direct contact.

Visitors. — *Vide supra.* W. J. Behrens says that humble-bees are the pollinators.

1941. C. macrostemma Pav. (Herm. Ross, Flora, Marburg, lviii, 1898, pp. 125–34.)—Hermann Ross states that the flowers of this species open in the evening, and appear to be adapted for pollination by hawk-moths. Should insect-visits fail,

the style describes rotatory movements, bringing the stigmas into contact with the anthers, so that automatic self-pollination necessarily takes place, and this is effective.

589. Collomia Nutt.

1942. C. grandiflora Dougl. (Ludwig, Bot. Ztg., Leipzig, xxxv, 1877; Scharlok, op. cit., xxxvi, 1878.)—Ludwig and Scharlok state that this species is cleistogamous.

1943. C. linearis Nutt. (Comes, 'Ult. oss.')—Comes describes this species as self-fertile.

LXX. ORDER *HYDROPHYLLACEAE* DC.

(including *HYDROLEACEAE* ENDL.)

Literature.—A. Peter, 'Hydrophyllaceae,' in Engler and Prantl's 'D. nat. Pflanzenfam.,' IV, 3 a, p. 57.

590. Phacelia Juss.

1944. P. tanacetifolia Benth. (Warnstorf, Verh. bot. Ver., Berlin, xxxvii and xxxviii, 1896.)—The flowers of this species are feebly protandrous. The style only bears stigmatic papillae on its extreme tip, and is at first curved inwards. The anthers dehisce a little before it straightens itself. Willis says the flowers are capable of automatic self-pollination (J. Linn. Soc., Bot., London, xxx, 1895).

The pollen-grains are of a pale bluish colour, biscuit-shaped, smooth, with several longitudinal streaks: they measure about 16–19 μ in breadth and 37·5 μ in length.

Visitors.—Warnstorf observed the honey-bee, and Herm. Müller noticed the following in his garden at Lippstadt ('Weit. Beob.,' III, p. 9).—

A. Coleoptera. 1. Dasytes flavipes *F.*, po-dvg.; 2. Meligethes sp., po-dvg. *Staphylinidae*: 3. Tachyporus obtusus *L.*, its mouth-parts busy with the anthers. **B. Diptera.** *Syrphidae*: 4. Rhingia rostrata *L.*, skg. and po-dvg. **C. Hymenoptera.** *Apidae*: 5. Apis mellifica *L.* ☿, in very large numbers, skg.; 6. Bombus hortorum *L.* ♀ and ☿, freq., skg.; 7. Halictus sexnotatus *K.* ♀, do.; 8. Osmia rufa *L.* ♀, do.

1945. P. divaricata A. Gray.—Willis states (op. cit.) that the flowers of this species are capable of automatic self-pollination.

1946. P. campanularia A. Gray; **1947. P. Whitlavia** A. Gray; and **1948. P. Parryi** Torr.—Willis states (op. cit.) that these species bear large brightly coloured flowers, adapted for cross-pollination.

591. Hydrophyllum L.

Flowers protandrous; with completely concealed nectar, secreted by the base of the ovary, and stored in a cavity of the petals.

1949. H. virginicum L. (Francke, Inaug. Dissert., Halle, 1883; Loew, 'Blütenbiol. Beiträge,' I, pp. 21–4.)—The flowers of this species are almost exclusively allogamous. Loew states that the nectar secreted in the base of the flower

rises into a series of prismatic tubes, each bounded by a pair of longitudinal folds and the midrib of a petal.

Visitors.—Loew (Berlin Botanic Garden) observed the honey-bee and the humble-bee Bombus terrester *L.* ♀, vainly trying to suck. He regards as the true pollinators insects that can probe the flowers without alighting, i. e. Bombyliids or hawk-moths.

592. Nemophila Nutt.

1950. N. maculata Benth. (Willis, J. Linn. Soc., Bot., xxx, 1895.)—The very conspicuous flowers of this species are protandrous.

Visitors.—In England, more particularly bees.

593. Hydrolea L.

1951. H. spinosa L. (Willis, op. cit.)—Willis states that the odourless blue flowers of this species are adapted to self-pollination, and that this is effective.

594. Wigandia H. B. et K.

1952. W. caracasana H. B. et K. (Francke, Inaug. Dissert., Halle, 1883.)—Francke states that this species is protogynous.

LXXI. ORDER *BORAGINEAE* DESV.

Literature.—Herm. Müller, 'Fertilisation,' pp. 408–23, 'Alpenblumen,' pp. 265–7; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 107, 'Grundriss d. Blütenbiol.,' pp. 76–7; Loew, Ber. D. bot. Ges., Berlin, iv, 1886, p. 152; M. Gürke, 'Boraginaceae,' in Engler and Prantl's 'D. nat. Pflanzenfam.,' IV, 3 a, pp. 78–9.

A considerable but variable number of flowers are associated in cymes, often of scorpioid character. They may be rotate, tubulo-campanulate, or infundibuliform, and secrete nectar from the receptacle immediately below the ovary. It is stored in the corolla-tube, the throat of which is often provided with scale-like appendages promoting concealment. The native German species consequently belong to flower class **C,** especially the sub-class **H,** for the visitors are almost exclusively bees. Crossing by insect-visits is ensured or favoured by dimorphism in Pulmonaria; by marked protandry in Echium and Borago; by exsertion of the stigma in Cerinthe, Symphytum, and Anchusa; and in Lithospermum, Echinospermum, Myosotis, and Omphalodes by contraction of the corolla-tube, securing that stigma and anthers shall be touched by opposite sides of the proboscis of an insect visitor. Should insect-visits fail, the facility with which automatic self-pollination may take place in a given species is inversely proportional to the conspicuousness of the flowers and their richness in nectar. Cerinthe, Echium, and Pulmonaria, owing to their great conspicuousness and large amount of nectar, receive such a large number of visits that automatic self-pollination is excluded. On the other hand, according to Hermann Müller, the small scantily nectar-secreting flowers of Lithospermum arvense *L.*, Myosotis intermedia *Link*, M. collina *Hoffm.*, and so forth, are very rarely visited by insects, and almost always pollinate themselves. There are numerous transitions between these two extreme cases.

Many forms limit access to their nectar entirely or almost so to bees, e.g.—Pulmonaria by elongation of the corolla-tube; Anchusa by closure of the entrance to the flower; Echium by the form of the corolla; Borago by torsion of the flowers, and apposition of the anthers into a cone closing their entrance; Symphytum and Cerinthe by elongation of the corolla-tube in addition to this. The species with shorter corolla-tubes from the genera Myosotis, Omphalodes, Echinospermum, Asperugo, Heliotropium, Lithospermum, and Cynoglossum, are visited by bees, Lepidoptera, and flies, more especially by hover-flies.

According to Kuhn (Bot. Ztg., Leipzig, xxv, 1867), species of the genera Amsickia, Eritrichium, Hockinia, and Lithospermum, are dimorphous. Darwin ('Different Forms of Flowers'), however, denies that this is the case in the first two of these, there being simply a large amount of variation in the length of the styles and stamens.

595. Heliotropium L.

Flowers fragrant, short-tubed, and homogamous; with very scanty or no secretion of nectar.

1953. H. europaeum L. (Kirchner, 'Beiträge,' pp. 49–50.)—The small insignificant flowers of this species are homogamous, and their odour is compared by Kerner to that of vanilla, by Delpino to that of jessamine. The limb of the corolla is 3–3½ mm. across, its throat is of a yellow colour, and its tube (2 mm. long) is entirely surrounded by the calyx. The yellow anthers are produced into points, and situated in the middle of the corolla-tube. The style projects beyond them, and bifurcates at its end into the pointed stigmas, which mature simultaneously with the anthers. During insect-visits crossing is therefore favoured, but these are infrequent. Kirchner was unable to discover any nectar in flowers from canton Valais.

1954. H. peruvianum L. (Sprengel, 'Entd. Geh.,' p. 87; Knuth, 'Bloemenbiol. Bijdragen.')—The bluish-white homogamous flowers of this species smell like vanilla.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (gardens in Kiel), the honey-bee, freq., inserting its proboscis into the base of the flowers; also the Muscid Calliphora vomitoria *L.*, skg. Errera and Gevaert, butterflies and the diurnal hawk-moth Macroglossa stellatarum *L.*

596. Asperugo L.

Flowers homogamous; with concealed nectar, secreted by the receptacle immediately below the ovary.

1955. A. procumbens L. (Kirchner, 'Beiträge,' p. 50; Knuth, 'Flora v. Helgoland.')—At Zermatt the inconspicuous flowers of this species are borne singly in the leaf-axils, and possess a corolla-tube scarcely 2 mm. long, with a dark-brown corolla limb and a violet ring in the throat. The entrance of the corolla-tube is narrowed by five whitish projections, formed by inpushings from the outside. The corolla-limb is generally directed obliquely upwards and is then only 3 mm. in diameter; more rarely it is horizontal, in which case it is 5 mm. across.

As the style is only ½ mm. long, the stigma is below the simultaneously maturing anthers, which alternate with the projections in the throat of the corolla, and are situated just under them. The anthers dehisce introrsely, so that automatic self-pollination is easily effected by fall of pollen on the stigma.

This species is very common on the high land of Helgoland, where fruits are always set, although insect-visits are very few, so that its self-fertility is beyond question.

Visitors.—Despite continuous watching during favourable weather in Helgoland I have only seen (5.6.'97) the small bee Andrena labialis *K.* ♂, skg.

597. Echinospermum Sw.

Flowers homogamous; with concealed nectar, secreted by the fleshy receptacle immediately below the ovary.

1956. E. Lappula Leh. (=Lappula Myosotis *Moench*, and Myosotis Lappula *L.*). (Herm. Müller, 'Weit. Beob.,' III, p. 19, 'Alpenblumen,' p. 261; Kirchner, 'Flora v. Stuttgart,' p. 553.)—So long as the corolla is enclosed in the bud it is white in colour, becoming pale-red when it emerges from the calyx, and ultimately sky-blue. Its limb is contracted in a companulate fashion, and five yellowish-white involutions which narrow its throat serve as nectar-guides. The inner margin of these appears yellow as seen from above, and there are ten radial white streaks. The simultaneously maturing stigmas and anthers are close together, and must be touched by opposite sides of the proboscis of an insect probing for the nectar at the bottom of the short corolla-tube, so that crossing is favoured. Should insect-visits fail, automatic self-pollination is inevitable, owing to the close proximity of anthers and stigmas. A proboscis of 6–7 mm. long is necessary to get at the nectar.

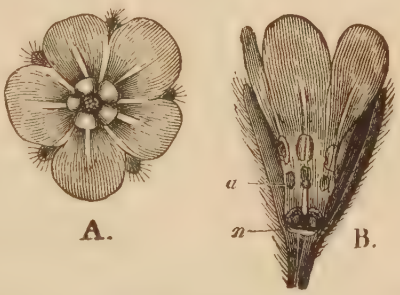


Fig. 200. *Echinospermum Lappula*, *L.* (after Herm. Müller). *A.* Flower, seen directly from above. *B.* Do., partly dissected from the side (× 7). *a*, anthers; *n*, nectaries.

Visitors.—Herm. Müller observed small hover-flies and 2 Lepidoptera in the Alps, and the following in Thuringia.—

A. Diptera. (*a*) *Muscidae*: 1. Anthomyia sp., skg. (*b*) *Syrphidae*: 2. Syritta pipiens *L.*, skg., freq. **B. Hymenoptera.** (*a*) *Apidae*: 3. Andrena sp. ♂, skg. (*b*) *Sphegidae*: 4. Cerceris variabilis *Schr.*, freq., persistently skg.

598. Cynoglossum L.

Flowers usually homogamous; with concealed nectar, secreted by the fleshy receptacle below the ovary, and concealed in the base of the corolla-tube.

1957. C. officinale L. (Sprengel, 'Entd. Geh.,' pp. 89–90; Herm. Müller, 'Weit. Beob.,' III, p. 19; Kirchner, 'Flora v. Stuttgart,' p. 553; Loew, 'Blütenbiol. Floristik,' p. 391; Knuth, 'Bloemenbiol. Bijdragen.')—The corolla-tube of the dirty-

purple flowers of this species is 3 mm. long and about the same breadth, but the access to the nectar is narrowed to 1 mm. by five pocket-shaped hollow scales in its entrance. The darker colour of these enables them to serve as nectar-guides, and their velvety covering of hairs as nectar-covers. The style projects in the middle of the flower to a height of 2 mm., and the five simultaneously maturing anthers project beyond it. As these dehisce introrsely automatic self-pollination necessarily takes place by the fall of pollen, should insect-visits fail. If the proboscis of an insect is inserted into the nectar-secreting base of the flower it touches pollen and stigma with opposite sides, so that cross-pollination is favoured.

Visitors.—Herm. Müller observed the following in Thuringia.—

A. Hymenoptera. *Apidae*: 1. Andrena nigroaenea *K.* ♀, skg., remaining a very long time (over ½ min.) on the flowers; 2. Apis mellifica *L.* ☿, freq., skg.; 3. Halictus tetrazonius *Klg.* ♀, in large numbers, skg. **B. Lepidoptera.** *Rhopalocera*: 4. Lycaena aegon *S. V.* ♂, skg. **C. Thysanoptera.** 5. Thrips, very common.

The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel), the honey-bee and the humble-bee Bombus terrester *L.*, both skg. Loew (North Germany), a bee (Osmia sp.). Gerstäcker (Berlin), the bee Osmia adunca *Ltr.*

1958. C. pictum Ait.—Kerner describes this species as feebly protogynous.

1959. C. Columnae Bivona.—

Visitors.—Loew observed the honey-bee and the humble-bee Bombus pratorum *L.*, both skg., in the Berlin Botanic Garden.

599. Omphalodes Tourn.

As Cynoglossum.

1960. O. verna Moench (=Cynoglossum Omphalodes *L.*). (Herm. Müller, 'Fertilisation,' pp. 416–17.)—The flower mechanism of this species agrees essentially with that of Echinospermum. The tube of the corolla is 3 mm. long, while its limb expands into a blue surface 15–18 mm. in diameter. During insect-visits crossing is favoured, but should they fail automatic self-pollination is inevitable.

Visitors.—Herm. Müller observed 2 bees—Bombus terrester *L.* ♀, and Osmia rufa *L.* ♂, both skg.

600. Eritrichium Schrad.

1961. E. villosum Bunge—This species bears fragrant flowers.

Visitors.—Ekstam observed flies in Nova Zemlia.

1962. E. aretioides A. DC. (= Myosotis aretioides *Cham.*).—This species was discovered by Chamisso in Tschukschenland and Kamchatka.

601. Rindera Pall.

1963. R. tetraspis Pall.—

Visitors.—Friese (*teste* Becker) observed two po-cltg. bees (Eucera albofasciata *Friese*, and E. velutina *Mor.*) at Sarepta.

602. Caccinia Savi.

1964. C. strigosa Boiss. (Loew, Ber. D. bot. Ges., iv, 1886, pp. 164–6.)—The corolla-tube of this species is 14 mm. long and $2\frac{1}{2}$ mm. broad. The five stamens are of various lengths; one of them is as long as the widely exserted style, two are about 2 mm. shorter than this, and the remaining two are still shorter. Since the four latter stamens dehisce first, autogamy is excluded to begin with, and crossing by insect-visits favoured. Should these fail, automatic self-pollination can ultimately take place when the long stamen dehisces.

Visitors.—Loew observed the humble-bee Bombus hortorum *L.* in the Berlin Botanic Garden, skg., and dusting its under-side with pollen.

603. Arnebia Forsk.

1965. A. echioides A. DC. (=Macrotomia echioides *Boiss.*). (Loew, op. cit., iv, 1886, pp. 164–6.)—This species is particularly interesting because the dark-violet spots on the corolla serving as nectar-guides gradually disappear after one to three days' anthesis, i. e. the 'nectar signals' are temporary, and exist only on the younger flowers.

As the nectar is very deeply concealed, besides which Loew observed the humble-bee Bombus hortorum *L.*, skg., the flowers may be referred to flower class **Hh.**

Loew describes a long-styled plant from the Berlin Botanic Garden as exhibiting much reduced fertility, but not self-sterile.

Visitors.—*Vide supra.*

604. Trachystemon D. Don.

1966. T. orientale D. Don (=Psilostemon orientale *DC.*). (Loew, op. cit., iv, 1886, pp. 155–7.)—The flowers of this species possibly belong to class **L.**

605. Borago L.

Protandrous bee flowers; with nectar secreted by the receptacle below the ovary, and concealed in a short tube formed by the roots of the filaments.

1967. B. officinalis L. (Sprengel, 'Entd. Geh.,' pp. 94–8; Herm. Müller, 'Fertilisation,' pp. 409–11, 'Weit. Beob.,' III, p. 14; Kirchner, 'Flora v. Stuttgart, pp. 554–5; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 275.)—The sky-blue hanging flowers expand so as to present a nearly flat surface, from the centre of which the black cone of anthers projects. The anthers which converge to make up this cone dehisce introrsely from apex to base, and the smooth powdery pollen falls into the end of the cone. This surrounds the style with its stigma, but as the latter is still immature automatic self-pollination is excluded. After nectar-sucking insects have removed the pollen from the cone the style grows out of it, and the stigma matures. Only bees are able to open the flowers. When one of these hangs on from below to a flower in the first stage of anthesis, and probes for nectar, its proboscis must be inserted between two filaments, thus

causing the displacement of two anthers. The apex of the anther-cone is consequently opened, and pollen is sprinkled on the under-side of the visitor. Even repeated visits do not permanently open the cone, for the short filaments are broad, and fleshy inwardly directed pouches of the corolla (which surround the base of the cone) direct the stamens back to their original position. The pollen received by bees from younger flowers is deposited on the stigmas of older ones in the second (female) stage.

Should insect-visits fail, automatic self-pollination may take place to a limited extent, for the pollen remaining in the cone can fall upon the stigma, though Darwin says this is an exceptional occurrence.

Bees grasp the tooth-like appendages of the filaments with their claws, thus displacing the anthers and causing the pollen to fall. Warnstorf describes the pollen-grains as white in colour, in shape like two apposed hemispheres with a central groove, smooth, up to 43 μ long and 25–8 μ broad.

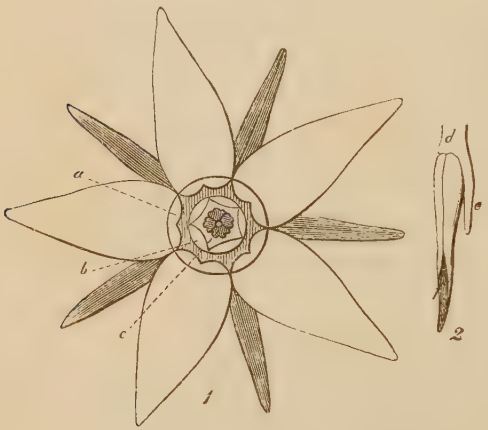


FIG. 270. *Borago officinalis*, *L.* (after Herm. Müller). (1) Flower, after removal of the stamen, seen directly from below. (2) A stamen in the natural position, seen from the side. *a*, pouches of the corolla; *b*, roots of the stamens; *c*, ovaries; *d*, fleshy thickened filament; *e*, process of do.; *f*, opening of anther.

VISITORS.—Herm. Müller (H. M.) for Westphalia, and Buddeberg (Budd.) give the following list.—

A. Hymenoptera. (*a*) *Apidae*: 1. Anthidium oblongatum *Ltr.* ♀, skg. (Budd.); 2. Apis mellifica *L.* ☿, very numerous, skg. and po-cltg. (H. M.); 3. Bombus pratorum *L.* ♀ and ☿, skg. and po-cltg. (H. M., Budd.); 4. Halictus sexnotatus *K.* ♀, freq., skg. (H. M.); 5. H. zonulus *Sm.* ♀, skg. (H. M.); 6. Megachile centuncularis *L.* ♂, in large numbers, skg. (H. M., Budd.); 7. M. fasciata *Sm.* ♂, do. (Budd.); 8. Osmia fulviventris *Pz.* ♂, do. (Budd.); 9. O. rufa *L.* ♀, skg. (Budd.). (*b*) *Vespidae*: 10. Odynerus parietum *L.* ♂, skg. (?). **B. Lepidoptera.** *Noctuidae*: 11. Plusia gamma *L.*, skg., in the evening (H. M.).

The following were recorded by the observers, and for the localities stated.—

Knuth, 2 bees—Apis mellifica *L.* ☿, and Bombus terrester *L.* ♂, both skg. Friese (Hungary), 2 bees—Eucera crinipes *Sm.*, and E. nitidiventris *Mocs.*

606. Anchusa L.

Homogamous bee flowers; nectar secreted by the four-lobed base of the ovary, and concealed in the lower part of the corolla-tube.

1968. A. officinalis L. (Sprengel, 'Entd. Geh.,' p. 89; Herm. Müller, 'Fertilisation,' p. 411, 'Weit. Beob.,' III, pp. 15–16, 'Alpenblumen,' p. 261; Loew, 'Blütenbiol. Floristik,' p. 391; Knuth, 'Blütenbiol. Beob. a. d. Ins. Rügen'; Tullberg, Bot. Not., Lund, 1868, p. 14.)—In this species the limb of the corolla

is at first concave and of a violet colour, but expands later on into a dark-blue, five-lobed star. The corolla-tube is 7 mm. long, and its entrance is blocked up by five closely apposed pocket-shaped hispid involutions, so as to give protection against rain and unbidden guests (flies). These pouches may be seen externally as transverse slits at the bases of the corolla-lobes. They also play the part of nectar-guides. The stigma is situated immediately below them, while the simultaneously maturing anthers are placed about the middle of the corolla-tube, and dehisce introrsely. Visitors (bees or Lepidoptera) must first touch the stigma, pollinating it if they have come from another flower, and then the pollen-covered anthers, thus effecting crossing. Should insect-visits fail, automatic self-pollination takes place as a last resort, for the corolla drops off and the anthers, to which some pollen still clings, are drawn over the stigma.

Gynomonoeciously or gynodioeciously distributed female flowers have been observed, though rarely, in addition to the hermaphrodite ones. Schulz ('Beiträge') states that they occur sporadically in larger numbers, and result from the reduction of stamens in a small-flowered hermaphrodite variety.

FIG. 271. *Anchusa officinalis*, *L.* (after Herm. Müller). (1) Flower seen from above. (2) Do. after removal of half the calyx and corolla, seen from the side. *n*, nectary.

According to Schulz the hermaphrodite flowers do not everywhere possess the same mechanism. They are not only of different sizes, but the relative position of stigma and anthers is variable even in flowers on the same stock. Sometimes the stigma is higher than the anthers (as in the description already given from the accounts of Sprengel and Herm. Müller, and verified by myself in Rügen), sometimes lower, or at the same level. Warming even noticed heterostyly in Denmark, while Schulz remarked it, though not in a pronounced form, in Germany and the Tyrol. Kirchner describes well-marked dimorphism for garden plants, the style of one form being $4\frac{1}{2}$ mm. long, and that of the other 8 mm. Where the stigma is at the same or a lower level than the anthers, automatic self-pollination is more easily possible than in long-styled flowers, for it can take place simply by the fall of pollen. Generally, however, this possibility is not made use of, for insect-visits are extremely numerous.

VISITORS.—Herm. Müller gives the following list for Westphalia (W.) and Thuringia (T.).—

A. Hymenoptera. (*a*) *Apidae*: 1. Anthophora aestivalis *Pz.* ♀, skg. (T.); 2. A. quadrimaculata *Pz.* ♀ and ♂, do. (T.); 3. Apis mellifica *L.* ☿, numerous, skg. and po-cltg. (W. and T.); 4. Bombus agrorum *F.* ♀, ☿ and ♂, skg. (W. and T.); 5. B. lapidarius *L.* ♂ and ☿, do. (W.); 6. B. pratorum *L.* ♀, ☿ and ♂, skg. and po-cltg. (W. and T.); 7. B. muscorum *F.* (W.) ♀ and ☿, skg. (W. and T.); 8. B. sylvarum *L.* ☿, skg. and po-cltg. (W.); 9. B. tristis *Seidl.* ☿, skg. (T.); 10. Coelioxys conoidea *Ill.* ♂, do. (T.); 11. Melecta luctuosa *Scop.* ♀, do. (T.); 12. Osmia caementaria *Gerst.* ♂,

do. (T.); 13. O. emarginata *Lep.* (=O. mustelina *Gerst.*) ♀, do. (T.); 14. Psithyrus rupestris *F.* ♀, do. (T.); 15. Saropoda bimaculata *Pz.* ♀ and ♂, do. (T.). (*b*) *Formicidae*: 16. Undetermined sp., vainly trying to force their way into the flowers (T.). **B. Lepidoptera.** *Noctuidae*: 17. Plusia gamma *L.*, extremely numerous, skg. (W.).

Friese records the following bees for Fiume (F.), Mecklenburg (M.), Switzerland (S.), the Tyrol (T.), Trieste (Tr.), and Hungary (H.).—

1. Anthidium interruptum *F.* (H.); 2. A. variegatum *F.* (H.); 3. Andrena nasuta *Gir.*, occasional (M.), freq. (H.); 4. Colletes nasutus *Sm.*, freq. (M.); 5. Eucera bibalteata *Dours.*, infreq. (M.); 6. E. chrysopyga *Pér.*, freq. (H.); 7. E. hungarica *Friese* ♂, not infreq. (H.); 8. E. interrupta *Baer*, not infreq. (H.); 9. E. longicornis *L.*, freq. (M.); 10. E. nitidiventris *Mocs.*, freq. (H.); 11. E. paradoxa *Mocs.*, infreq. (H.); 12. E. seminuda *Brullé* ♂, one (H.); 13. E. semistrigosa *Dours.*, freq. (H.); 14. E. tricincta *Er.* (Tr.); 15. Halictus morbillosus *Kriechb.*, very common (H.); 16. H. patellatus *Mor.* (F., *teste* Korlevič), not infreq. (H.); 17. H. xanthopus *K.* (T., H.); 18. Nomada nobilis *Mor.*, not infreq. (F., M.); 19. N. sexfasciata *Pz.* (M.); 20. Nomia femoralis *Pall.*, occasional (F., H.); 21. Osmia caerulescens *L.*, not infreq. (M.); 22. O. notata *F.*, freq. (H.); 23. O. spinolae *Schenck* (H.); 24. Podalirius albigenus *Lep.*, not infreq. (T., S., H.); 25. P. crinipes *Sm.*, freq. (H.); 26. P. magnilabris *Fedtsch*, occasional (F., H.); 27. P. pubescens *F.*, freq. (S., T.), not infreq. (H.); 28. P. quadrifasciatus *Vill.*, not infreq. (F., Tr., H.); 29. P. salviae *Mor.*, infreq. (F., H.); 30. P. vulpinus *Pz.*, freq. (M.), not infreq. (F., H.).

Loew observed the following in Brandenburg ('Beiträge,' p. 43).—

A. Diptera. *Bombyliidae*: 1. Systoechus sulphureus *Mikan.*, skg. **B. Hymenoptera.** (*a*) *Apidae*: all skg.: 2. Andrena nasuta *Gir.* ♀, po-cltg.; 3. Bombus cognatus *Steph.* ♀; 4. B. distinguendus *Mor.* ☿; 5. B. lapidarius *L.* ☿; 6. B. latreillellus *K.* ♀; 7. B. rajellus *K.* ♀; 8. B. sylvarum *L.* ☿; 9. B. terrester *L.* ☿; 10. Coelioxys punctata *Lep.* ♀; 11. Colletes nasutus *Sm.* ♀ and ♂, numerous, the ♀ po-cltg.; 12. Epeolus variegatus *L.*, ♀ and ♂; 13. Megachile maritima *K.* ♂; 14. Psithyrus campestris *Pz.* ♀; 15. P. rupestris *Pz.* ♀; 16. Tetralonia pollinosa *Lep.* ♀, going steadily from flower to flower. (*b*) *Sphegidae*: 17. Bembex rostrata *L.* ♀ and ♂, skg. **C. Lepidoptera.** *Rhopalocera*: 18. Pieris daplidice *L.*, skg.; 19. Vanessa cardui *L.*, do.

The following were recorded by the observers, and for the localities stated.—

Knuth (Rügen), 5 bees, all skg.—1. Bombus agrorum *F.* ☿; 2. B. hortorum *L.* ♀ and ☿; 3. B. lapidarius *L.* ☿ and ♀; 4. B. rajellus *K.* ☿; 5. B. sylvarum *L.* ☿. Schmiedeknecht (Thuringia), 3 bees—1. Andrena nasuta *Gir.*; 2. Bombus hypnorum *L.* ♀; 3. B. pratorum *L.* ♂. Gerstäcker (Berlin), 2 bees—Osmia adunca *Ltr.* and O. spinolae *Schenck*. Hoffer (Steiermark), the humble-bee Bombus hypnorum *L.* ♀. Schulz (Bozen), perforations made by the humble-bee Bombus terrester *L.* Schletterer and von Dalla Torre (Tyrol), 6 bees—1. Bombus agrorum *F.*; 2. B. sylvarum *L.*; 3. Osmia caerulescens *L.*; 4. O. rufa *L.*, very common; 5. Podalirius acervorum *L.*; 6. P. aestivalis *Pz.* ♀. Friese (Hungary), the bee Eucera curvitarsis *Mocs.* H. de Vries (Netherlands), the humble-bee Bombus agrorum *F.* ☿ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875).

1969. A. sempervirens *L.* (=Caryolopha sempervirens *Fisch. et Traut.*). (Loew, 'Blütenbiol. Floristik,' p. 280, Ber. D. bot. Ges., iv, 1886, pp. 163–4.)—This species is native to England and South Europe, and Loew examined it in the Berlin Botanic Garden, his account being somewhat as follows.—

In the sky-blue flowers there are five hispid hollow valves of white colour in the throat of the corolla, which leave only an opening ¾ mm. wide between them. The nectaries are situated at the bottom of the corolla-tube, and are covered by four

short inwardly directed hairy projections, rendering access to the nectar still more difficult. A bee which inserts its proboscis into the entrance of the flower touches the dilated stigma with one side of this organ and the anthers with the other, so that during further visits it can easily effect cross-pollination. (*Cf.* Lithospermum.) The stigma is in the middle of the anthers, so that automatic self-pollination is inevitable should insect-visits fail.

Visitors.—Loew observed the honey-bee, skg., as a particularly frequent visitor in the Berlin Botanic Garden, so that the flowers can undoubtedly be referred to class **Hb**; the bees Osmia rufa *L.*, and Halictus cylindricus *F.* ♀. A butterfly (Pieris brassicae *L.*) was also seen, inserting its proboscis into the bases of the flowers.

1970. A. ochroleuca Bieb. (Loew, Ber. D. bot. Ges., Berlin, iv, 1886, pp. 162–3.)—The flower mechanism of this species agrees essentially with that of A. officinalis.

Visitors.—Loew observed the following 7 bees in the Berlin Botanic Garden, partly skg., partly po-cltg.—

1. Apis mellifica *L.* ☿, skg.; 2. Bombus agrorum *F.* ☿, do.; 3. B. hortorum *L.* ☿, do.; 4. B. lapidarius *L.* ☿, do.; 5. B. pratorum *L.* ☿, do.; 6. Osmia rufa *L.* ♂, do.; 7. Prosopis armillata *Nyl.* ♀, po-dvg.

1971. A. italica Retz. (=A. paniculata *Ait.*).

Visitors.—Schletterer and von Dalla Torre record 4 bees for the Tyrol.—

1. Andrena thoracica *F.* ♀; 2. Megachile muraria *L.* ♀; 3. Osmia rufa *L.* ♀, very common; 4. Prosopis bipunctata *F.*

607. Lycopsis L.

As Anchusa, but corolla-tube bent in the middle.

1972. L. arvensis L. (=Anchusa arvensis *Bieb.*). (Herm. Müller, 'Fertilisation,' pp. 411, 'Weit. Beob.,' III, p. 16; Kirchner, 'Flora v. Stuttgart,' p. 555; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 331; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 107, 164.)—The flower mechanism of this species agrees with that of Anchusa officinalis (chief type) as regards—secretion and concealment of nectar; nectar-guides and nectar-covers; promotion of cross-pollination during insect-visits by projection of the stigma beyond the anthers; and the possibility of automatic self-pollination towards the end of anthesis by fall of the corolla, causing the anthers to be drawn over the stigma.

Visitors.—Heinsius observed the following in Holland.—

A. Hymenoptera. *Apidae*: 1. Bombus agrorum *F.* ☿ and ♀, numerous; 2. B. hortorum *L.* ☿; 3. B. lapidarius *L.* ♀; 4. B. rajellus *K.*; 5. B. scrimshiranus *K.* ♂; 6. Megachile maritima *K.* ♂; 7. Melecta luctuosa *Scop.* ♀; 8. Psithyrus barbutellus *K.* ♂; 9. P. campestris *Pz.* ♂; 10. P. rupestris *F.* ♂; 11. P. vestalis *Fourcr.* ♂. **B. Lepidoptera.** *Rhopalocera*: 12. Hesperia lineola *O.* ♂; 13. H. thaumas *Hfn.* ♂ and ♀; 14. Pararge megaera *L.* ♂; 15. Pieris brassicae *L.* ♀; 16. P. rapae *L.* ♀; 17. Vanessa urticae *L.* (Bot. Jaarb. Dodonaea, Ghent, iv, 1892).

Knuth (Röm) only noticed a hover-fly (Helophilus pendulus *L.*), skg., and Herm. Müller (Thuringia) a butterfly (Hesperia thaumas *Hfn.*), skg.

608. Nonnea Moench.

1973. **N. pulla** DC. (=N. erecta *Bernh.*, and Lycopsis pulla *L.*).—The flowers of this species are of a dark or light purple-brown colour, rarely bright yellow or almost white.

Visitors.—Friese observed the following 7 bees in Hungary.—

1. Eucera hungarica *Friese* ♂; 2. E. difficilis *Pérez*; 3. E. interrupta *Baer*; 4. E. nitidiventris *Mocs.* ♂; 5. E. parvicornis *Mocs.*; 6. E. clypeata *Er.* ♂; 7. E. chrysopyga *Pér.* ♂.

Schulz noticed perforated flowers here and there at Halle ('Beiträge').

609. Symphytum Tourn.

Homogamous bee flowers; with nectar secreted by an annular ridge at the base of the ovary, and stored in the base of the corolla. According to Kerner, the peduncle bends down in late anthesis, so that the flower assumes a nodding or pendulous position, and the stigma is brought into the line of fall of the pollen, thus rendering automatic self-pollination inevitable.

1974. **S. officinale** L. (Sprengel, 'Entd. Geh.,' pp. 93–4; Herm. Müller, 'Fertilisation,' pp. 408–9, 'Weit. Beob.,' III, p. 14; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 275; Kirchner, 'Flora v. Stuttgart,' p. 556; Knuth, 'Bloemenbiol. Bijdragen'; Schulz, 'Beiträge,' II; Loew, 'Blütenbiol. Floristik,' pp. 279–80.)—The drooping flowers of this species are white or violet-purple in colour, and their mechanism resembles that of Borago. The bell-shaped corolla is 14 mm. long, and it is contracted above for a distance of 8 mm., so that only long-tongued insects can suck the nectar legitimately. At the junction of the narrow and broader portions of the corolla there are triangular hollow scales, alternating with the filaments and covering the spaces between them. The spiny edges of these appendages prevent visitors from probing for nectar between the filaments, and they are obliged to insert their proboscis in such a way that it must get dusted with pollen.

Fig. 272. *Symphytum officinale*, *L.* (from nature). *A*. Flower seen from the side. *B*. Do., partly dissected. *a*, anthers, placed within the hollow scales; *s*, stigma.

The anthers converge to form a hollow cone surrounding the style, and they dehisce introrsely in the bud, some of the pollen falling into the apex of the cone and some remaining clinging to them. When an insect probes for nectar with its proboscis the anthers are displaced and some of the pollen falls out. The projecting stigma is the first part of the flower to be touched by a visitor, after which it is dusted by pollen. The arrangement is favourable to crossing by insect-visits, but should these fail automatic self-pollination apparently takes place. Kerner states that the flower is at first horizontal, but comes to droop in late anthesis owing to a bending

of the peduncle, so that the stigma is brought into the line of fall of the pollen, when autogamy results.

A proboscis of at least 11 mm. in length is required to reach the nectar by probing between the anthers, but one of 8 mm. would be able to get at it between the filaments. As already explained, however, the latter way is barred by means of hollow scales, the edges of which are beset with minute prickles. Insects with a proboscis less than 11 mm. long can therefore only secure the nectar by perforating the corolla. This is done extremely often by three kinds of humble-bee, i.e. Bombus terrester *L.* ☿ (proboscis 7–9 mm.), B. pratorum *L.* ☿ (prob. 8–9 mm.), and B. lapidarius *L.* ☿ (prob. 9–10 mm.). The honey-bee also sucks nectar through the holes thus made, but Loew says that but little harm is done to the flowers in this way. Warnstorff describes the pollen-grains as white in colour, ellipsoidal, smooth, on an average 33 μ long and 27 μ broad.

Visitors.—Herm. Müller gives the following list, in which only those insects indicated by an asterisk (*) suck legitimately and effect pollination.—

A. Coleoptera. *Nitidulidae*: 1. Meligethes. **B. Diptera.** *Syrphidae*: 2. *Rhingia rostrata *L.*, skg. **C. Hymenoptera.** *Apidae*: 3. *Anthophora personata *Ill.*, skg.; 4. *A. pilipes *F.* ♀; 5. Apis mellifica *L.* ☿, carefully examining the bases of the flowers, but not perforating them; only skg. through holes (made by Bombus terrester) already present (Westphalia and Strasburg); 6. Bombus agrorum *F.* ♀ and ☿, very common, skg. legitimately (Westphalia and Strasburg); 7. B. lapidarius *L.* ☿, perforating the narrow part of the corolla-tube from outside; 8. B. pratorum *L.* ☿, do.; 9. *B. rajellus *K.* ♀ and ☿; 10. *B. sylvarum *L.* ♀ and ☿; 11. B. terrester *L.* ♀, as 7 (Westphalia and Strasburg); 12. Eucera longicornis *L.* ♂, creeping right into the flowers; 13. Halictus sexnotatus *K.* ♀, skg. through holes made by humble-bees; 14. *Osmia aenea *L.* ♀, skg. (Strasburg); 15. *Xylocopa violacea *L.* ♀ and ♂, skg. (Strasburg).

Loew observed the following bees in the Berlin Botanic Garden.—

1. Anthidium manicatum *L.*, using holes made by humble-bees; 2. Andrena nitida *Fourcr.* ♀, po-cltg.; 3. Anthophora pilipes *F.* ♀, skg.; 4. Apis mellifica *L.* ☿, skg. through holes made by humble-bees; 5. Bombus agrorum *F.* ☿, skg.; 6. B. hortorum *L.* ♀, skg. legitimately; 7. B. hypnorum *L.* ☿, skg.; 8. B. lapidarius *L.* ☿, do., and perforating the flowers; 9. B. terrester *L.* ☿, perforating the flowers; 10. Halictus sexnotatus *K.* ♀, creeping into the flowers and trying to suck. Also in the var. *coccineum* Hort.—11. Bombus pratorum *L.* ☿, vainly skg.

The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel), the following 7 bees, skg. legitimately—1. Bombus agrorum *F.* ♀; 2. B. hortorum *L.* ☿; 3. B. lapidarius *L.* ♀; 4. B. rajellus *K.* ☿, as a nectar-thief; 5. Apis mellifica *L.* ☿; 6. Bombus lapidarius ☿; 7. B. terrester *L.* ♀. von Fricken (Westphalia and East Prussia), the Nitidulid beetle Meligethes symphyti *Heer*. Alfken (Bremen), 5 bees—1. Bombus agrorum *F.* ☿; 2. B. arenicola *Ths.* ♀; 3. B. derhamellus *K.* ☿; 4. B. lucorum *L.* ♀; 5. B. ruderatus *F.* ♀, skg. Krieger (Leipzig), the bee Eucera longicornis *L.* ♂. MacLeod (Flanders), 8 humble-bees, 2 bees (Eucera sp.; and Apis, stealing nectar), a hover-fly, and a Lepidopterid (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 333). H. de Vries (Netherlands), 3 humble-bees—1. Bombus agrorum *F.* ☿; 2. B. hypnorum *L.* ☿; 3. B. pratorum *L.*, var. subinterruptus *K.* ☿ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875). Scott-Elliot (Dumfriesshire), 3 humble-bees ('Flora of Dumfriesshire,' p. 123).

1975. S. cordatum Waldst. et Kit. (Loew, 'Blütenbiol. Floristik,' p. 280.)—This Hungarian species bears yellowish-white flowers, which are shorter than those

of S. officinale, but with longer prickles on the triangular scales, according to a description given by Loew of plants cultivated in the Berlin Botanic Garden.

1976. S. tuberosum L.—

Visitors.—The following were recorded by the observers, and for the localities stated.—

Ducke (Trieste and Austrian Silesia) and Friese (Fiume and Hungary), as a typical visitor the bee Andrena symphyti *Pér.* ♀ skg. and po-cltg., ♂ skg. Loew (Berlin Botanic Garden), 4 bees (Ber. D. bot. Ges., Berlin, iv, 1886, p. 160)—1. Anthophora pilipes *F.*, steadily skg.; 2. Apis mellifica *L.* ☿, po-cltg.; 3. Bombus hortorum *L.* ♀, skg.; 4. B. lapidarius *L.* ♀, skg. (?).

1977. S. grandiflorum DC.—

Visitors.—Loew (Berlin Botanic Garden) observed the same 4 bees as for S. tuberosum (loc. cit.).

1978. S. asperrimum Donn.—

Visitors.—The following were recorded by the observers, and for the localities stated.—

Morawitz (Caucasus), 2 bees—Bombus vorticosus *Gerst.*, and Podalirius parietinus *F.* Loew (Berlin Botanic Garden), the honey-bee, skg. through perforations made by humble-bees, and the humble-bee Bombus terrester *L.*, vainly (?) skg.

1979. S. caucasicum Bieb.—

Visitors.—Loew observed the bee Anthophora pilipes *F.* ♀, skg., in the Berlin Botanic Garden.

1980. S. peregrinum Ledeb. (=S. asperrimum *Donn*, according to the *Index Kewensis*).—

Visitors.—Loew observed 7 bees in the Berlin Botanic Garden.—

1. Anthidium manicatum *L.* ♀, skg. through holes made by humble-bees; 2. Anthophora pilipes *F.* ♂, skg.; 3. Bombus agrorum *F.* ☿, skg. and po-cltg.; 4. B. hortorum *L.* ♀ and ☿, skg., and then visiting S. officinale; 5. B. hypnorum *L.* ☿, skg. legitimately; 6. B. pratorum *L.* ☿, perforating the flowers; 7. B. terrester *L.* ☿, first trying to suck legitimately and then thrusting its proboscis into holes made by humble-bees.

610. Pulmonaria L.

Heterostylous-dimorphous, usually homogamous humble-bee flowers; with nectar secreted by the four-lobed base of the ovary, stored in the lowest part of the corolla, and protected from rain by a ring of hairs in the throat of the corolla.

1981. P. officinalis L. (Sprengel, 'Entd. Geh.,' p. 91; Hildebrand, Bot. Ztg., Leipzig, xxiii, 1865, pp. 13–15; Herm. Müller, 'Fertilisation,' pp. 412–14, 'Weit. Beob.,' III, p. 16; Kirchner, 'Flora v. Stuttgart,' pp. 558–9; Schulz, 'Beiträge'; Loew, 'Blütenbiol. Floristik,' p. 1392; Knuth, 'Bloemenbiol. Bijdragen.')—The flowers of this species are at first of a red colour, but subsequently become blue-violet, while their openings widen a little, enabling insects to insert their heads for a few mm. into the uppermost part of the corolla-tube, so that a proboscis of 8 mm. is long enough to reach the nectar secreted at the base. In short-styled flowers (Sprengel only noticed these) the stamens are situated in the opening of the corolla-tube (10–12 mm. long) and the stigma about its middle. In long-styled flowers the style is 10 mm. in length, so that the stigma is situated in the entrance of the corolla-

tube, and the stamens half-way down. The pollen-grains of the short-styled flowers are larger than those of the long-styled ones.

Nectar-sucking bees or Lepidoptera touch the anthers or stigma in the entrance of the flower with their heads or the base of their proboscis, while the middle of the latter comes into contact with the reproductive organs placed half-way down the corolla-tube. Legitimate crossing is thus effected. Smaller insects which creep into the flowers bring about either legitimate or illegitimate union. Owing to the large amount of nectar in the flowers, their conspicuousness, and the fact that they flower very early in the year, when there are but few other competing species, insect-visits are very numerous. In correlation with this we find that the flowers are unable to automatically pollinate themselves (though Kerner says that the long-styled form may do so), and illegitimate union is ineffective. The experiments on artificial pollination carried out by Hildebrand have demonstrated that when flowers are fertilized by means of their own pollen, or that from others of the same kind, no fruits are set, while legitimate union is followed by about the same amount of fertility as in nature. It has further been shown by the researches of Cobelli (Nuovo Giorn. bot. ital., Firenze, xxv, 1893) that no fruits are set when visitors are excluded. In wild plants investigated by Hildebrand the first flowers were often infertile, and this was almost always the case with the terminal one on each branch. He suggests that the first fact can be explained on the assumption that there are no visitors when the plant begins to flower; while as to the second he suggests that the supply of nutriment passing up the branches is not sufficient to reach their tips, but is appropriated by the fruits developing below.

Schulz observed protandry as well as homogamy.

Visitors.—Herm. Müller gives the following list for Westphalia (W.) and Thuringia (T.).—

A. Coleoptera. *Staphylinidae*: 1. Omalium florale *Payk.*, freq., creeping about in the flowers (W.). **B. Diptera.** (*a*) *Bombyliidae*: 2. Bombylius discolor *Mg.*, freq., but only during warm sunshine, casually skg. (W.); 3. B. major *L.*, do. (W.). (*b*) *Syrphidae*: 4. Rhingia rostrata *L.*, very common, skg. (W.). **C. Hymenoptera.** *Apidae*: 5. Andrena gwynana *K.* ♀, po-cltg. (T.); 6. Anthophora pilipes *F.* ♂ and ♀, numerous, skg. and po-cltg. (W., T.); 7. Bombus agrorum *F.* ♀, freq., skg. (W.); 8. B. hortorum *L.* ♀, very common (W.); 9. B. lapidarius *L.* ♀, skg. (W.); 10. B. pratorum *L.* ♀, skg. (W., T.); 11. B. rajellus *K.* ♀, skg. (W., T.); 12. B. muscorum *F.* ♀, skg. (W.); 13. B. sylvarum *L.* ♀, freq., skg. (W., T.); 14. B. terrester *L.* ♀, skg. (W., T.); 15. Halictus cylindricus *F.* ♀, po-cltg. (W.); 16. Osmia fusca *Chr.*, ♀ and ♂, freq., skg. and po-cltg. (W.); 17. O. pilicornis *Sm.* ♂ and ♀, skg. and po-cltg. (W.); 18. O. rufa *L.* ♂, skg. (W.). **D. Lepidoptera.** *Rhopalocera*: 19. Rhodocera rhamni *L.*, freq., skg. (W.).

The following were recorded by the observers, and for the localities stated.—

Knuth, 5 bees, all skg. legitimately—1. Apis mellifica *L.* ☿ (2.5.'96, very numerous); 2. Anthophora pilipes *F.* ♀ and ♂ (25.4.'95); 3. Bombus agrorum *F.* ♀ (28.4.'96); 4. B. hortorum *L.* ♀ (25.4.'95); 5. B. lapidarius *L.* ♀ (28.4.'96). Bail (West Prussia), the butterfly Anthocharis cardamines *L.* (Bot. Centralb., Cassel, ix, 1882). Loew (Brandenberg), 3 bees ('Beiträge,' p. 46)—1. Anthophora pilipes *F.* ♂, skg.; 2. Bombus agrorum *F.* ♀, do.; 3. B. lapidarius *L.* ♀, do., one ♀ visited 100 flowers in about 4 minutes; (Berlin Botanic Garden), the bee Andrena nitida *Fourcr.* ♀, po-cltg. and, on a variety, 3 bees—1. Bombus agrorum *F.* ♀; 2. B. hortorum *L.*

♀, skg., and then visiting P. angustifolia; 3. Osmia rufa *L.* ♀, skg. Alfken (Bremen), 4 bees—1. Bombus agrorum *F.* ♀; 2. B. pratorum *L.* ♀; 3. Osmia rufa *L.* ♀ and ♂; 4. Podalirius acervorum *L.* ♀ and ♂; Schmiedeknecht (Thuringia), 2 bees—Bombus hortorum *L.* ♀, and B. pratorum *L.* ♀. Friese (Innsbruck), the bee Osmia uncinata *Gerst.*, occasional. Hoffer (Steiermark), the humble-bee Bombus agrorum *F.* ♀. Schulz noticed flowers perforated by Bombus terrester *L.*

Hermann Müller (Kosmos, Stuttgart, xii, 1883, pp. 214 et seq.) noticed that the bee Anthophora pilipes *F.* ♀ visited almost exclusively flowers either in the red stage or those just beginning to turn blue. Only a single individual went first to the blue flowers. In the same locality the bee Osmia rufa *L.* and two humble-bees (Bombus hypnorum *L.*, and B. hortorum *L.*) were also observed, visiting the blue flowers as well as the red, perhaps because during their brief stay they had not acquired the necessary experience. Müller considers that the blue flowers serve a double purpose; increasing the conspicuousness of the inflorescence, and also indicating to the more intelligent pollinators the flowers to which their visits should be limited to secure the best results for themselves and the plant.

1982. P. angustifolia L. (=P. azurea *Bess.*). (Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.,' p. 37; Herm. Müller, 'Alpenblumen,' pp. 263–4; MacLeod, 'Pyre-

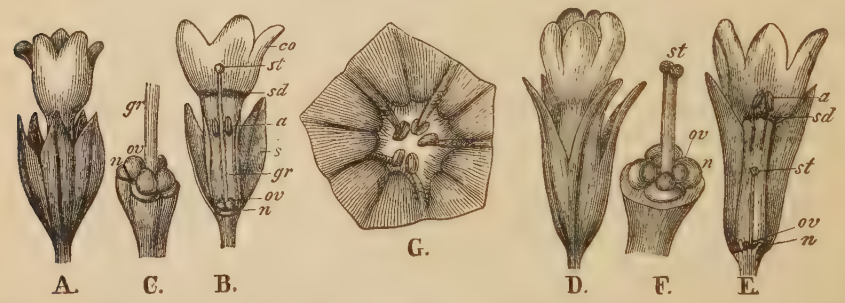


FIG. 273. *Pulmonaria angustifolia*, *L.* (after Herm. Müller). *A.* Long-styled flower (× 1½). *B.* Do., partly dissected from the sied. *C.* Ovary and nectary of the same (× 4⅔). *D.* Short-styled flower (× 1½). *E.* Do., partly dissected from the side. *F.* Ovary and nectary of the same (× 4⅔). *G.* Corolla-limb of the same, cut through just above the stamens, and seen from above to show the nectar-cover (× 4⅔). *a*, anthers; *co*, corolla; *gr*, style; *n*, nectary; *ov*, ovary; *s*, sepals; *sd*, nectar-cover; *st*, stigma.

neënbl.,' p. 310; Schulz, 'Beiträge,' II, pp. 113–15.)—The plants of this species examined by Hermann Müller in the canton Graubünden were homogamous and markedly heterostylous-dimorphous, the two forms exhibiting strong secondary differences besides those relating to the reproductive organs. The former were found by Schulz to be less clearly pronounced in the Tyrol, and were in some cases altogether absent. In that district, for example, the relative sizes of the different parts of the flowers were fairly constant, and the two forms usually agreed as to the nectaries and ovaries. Schulz found the styles of short-styled flowers to be 4–4½ mm. long, and those of long-styled ones 8–9 mm. The stigmatic papillae of the former appeared to be larger than those of the latter. The flowers present the same colour change as in P. officinalis, but the blue is darker and more intense.

VISITORS.—Loew saw the following in the Berlin Botanic Garden.—

A. Diptera. *Syrphidae*: 1. Cheilosia pulchripes *Lw.*, settled on corolla; 2. Syrphus corollae *F.*, do. **B. Hymenoptera.** *Apidae*: 3. Apis mellifica *L.* ☿, vainly

skg.; 4. Bombus hortorum *L.* ♀, skg.; 5. Halictus nitidiusculus *K.* ♀, creeping into the flowers; 6. Osmia rufa *L.* ♂ and ♀, skg. Also on the hybrid P. angustifolia × P. officinalis, 3 bees—1. Apis mellifica *L.* ☿, vainly skg.; 2. Bombus terrester *L.* ♀, skg.; 3. Osmia rufa *L.* ♂, do.

The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 6 humble-bees, a Bombylius, a Rhingia, and a Vanessa. Schulz, humble-bees and Lepidoptera, also flowers perforated by the former. MacLeod (Pyrenees), a humble-bee.

1983. P. tuberosa Schrank (= P. angustifolia *L.*, according to the *Index Kewensis*).—Haussknecht observed two forms of flower in this species at Kreuznach, i. e. gynodynamous with long calyx, and androdynamous with short calyx.

1984. P. mollis Wolff. (=P. montana *Lej.*). (Kirchner, 'Flora v. Stuttgart,' p. 560; Loew, 'Blütenbiol. Floristik,' p. 281.)—The flowers of this species agree with those of P. officinalis as regards colour change and mechanism, but are in all respects considerably larger. The calyx-tube is 11–14 mm. long, and its lobes 3–4 mm. While the corolla is in the red stage its lobes are erect and its diameter only 7–10 mm. By the time it has turned violet the lobes have spread out, increasing the diameter to 15 mm. The length of the corolla-tube up to its throat is 11–17 mm., the lower 8–9 mm. being uniformly cylindrical and $1\frac{1}{2}$–$2\frac{1}{2}$ mm. wide, and the upper part gradually widened into a funnel. In short-styled flowers the anthers and stigmas are respectively 9–13 mm. and 5–8 mm. above the receptacle, while in the long-styled ones they are 5–7 mm. and 11–13 mm. Loew adds that the hollow scales not mentioned in descriptions of Pulmonaria in systematic works, are here clearly recognizable as very low, small, hairy, bilobed projections within the corolla-tube.

Visitors.—Loew observed the honey-bee, vainly skg., in the Berlin Botanic Garden.

1985. P. saccharata Mill.—

Visitors.—Loew saw 2 bees, skg., in the Berlin Botanic Garden—Melecta armata *Pz.* ♀, and Osmia rufa *L.* ♂.

611. Onosma L.

Homogamous or feebly protandrous Lepidopterid flowers; with nectar secreted by a disk under the ovary, and stored in the base of the tubular corolla.

1986. O. stellulatum Waldst. et Kit. (Schulz, 'Beiträge,' II, p. 112.)—In this species the corolla-tube is bright yellowish-white above, passing into a darker shade below, 20–6 mm. in length and 6–8 mm. broad at its widest part. The short bifid tips of the anthers are at about the same level as the limb of the corolla, and their bases are laterally fused together for a short distance. As a rule the anthers dehisce introrsely immediately after the flower opens. They surround the style (20–7 mm. long), which at first does not project beyond them or scarcely so, but subsequently elongates so as to do so for 1–3 mm. The stigma matures at the same time as the anthers, or shortly afterwards.

Only hawk-moths can suck the nectar legitimately, and Schulz actually saw some of the larger species visiting the flowers in the evening at Bozen, but owing to the unfavourable nature of the ground was unable to capture them. An insect

of the kind when it approaches a flower first touches the stigma and then separates the united anthers, thus usually effecting crossing. Should insect-visits fail, automatic self-pollination is now and then possible, owing to the close proximity of the anthers and stigma just after the flowers open. Towards the end of anthesis, but not earlier as a rule, the corolla falls off and the stigma is drawn between the anthers so as to effect autogamy.

Visitors.—*Vide supra.* Ducke and Graeffe observed the very long-tongued bee Osmia macroglossa *Gerst.*, as a frequent and exclusive visitor at Bozen. Schulz saw a number of flowers perforated at the base by the humble-bee Bombus terrester *L.*

1987. O. echioides L. (= O. Vaudense *Gremli*). (Briquet, 'Études de biol. flor. dans les Alpes occident.')—The flowers of this species are sulphur-yellow in colour, smell like honey, and secrete abundant nectar from five little scales at the base of the corolla. Briquet says they are visited by humble-bees, bees, and butterflies, which regularly effect cross-pollination. The horizontal corolla is 20–3 mm. in diameter, and its entrance 5 mm. The long thin style projects 5 mm. from the flower, and is surrounded by the anthers, which are laterally fused at their bases. Kirchner states that, should insect-visits fail, automatic self-pollination can only be brought about by fall of the corolla.

Visitors.—*Vide supra.*

612. Cerinthe L.

Homogamous bee and humble-bee flowers; with nectar secreted by the swollen fleshy base of the ovary, and sheltered in the uppermost part of the pendulous bell-shaped corolla.

Kerner states that the peduncle bends down in late anthesis, causing the flower to assume a nodding or pendulous position, and bringing the stigma into the line of fall of the pollen, so that autogamy is inevitable.

1988. C. alpina Kit. (=C. glabra *Mill.*). (Herm. Müller, 'Alpenblumen,' pp. 264–6.) The pendulous flowers of this species are pollinated by humble-bees with a proboscis at least 9 mm. long. These visitors cling to the corolla from below, and insert their proboscis into its narrow opening. They first touch the widely exserted stigma, and their proboscis then strikes against the anthers, by which they are dusted with pollen.

Visitors.—Herm. Müller observed the humble-bee Bombus alticola *Krchb.* in the canton Graubünden.

1989. C. minor L. (Herm. Müller, 'Weit. Beob.,' III, pp. 9–14.)—In this species the nectar is less deeply hidden than in C. alpina, so that bees with a proboscis not less than 6 mm. long can reach the secreting base of the flower. In doing this they hold on to the corolla-lobes with their first and second pairs of legs, further supporting themselves by placing the hind ones on the same or neighbouring flowers, or on the bracts. The anthers are borne on short stiff filaments, and their tips are closely applied to the style, while their margins are in contact. The base of each anther-lobe is produced into a filiform appendage, which interlocks with the corresponding appendage of the adjacent lobe of the

neighbouring anther. The anthers thus collectively make up a pyramid closed all round, with its apex directed downwards, and its axis formed by the style. It becomes filled with the white powdery pollen when this is dehisced.

As the corolla-lobes converge, an insect visitor (bee) inserts its proboscis into one of the clefts between them, causing two stamens to become to some extent separated. The anther pyramid is thus opened, and some of the dry powdery pollen falls upon the under-side of the bee's head. As the stigma projects from the flower it is first touched by the bee or humble-bee paying the visit, and pollen brought from other flowers will be transferred to it. Crossing by insect-visits is thus ensured, and the form of the inflorescence favours the transfer of pollen from one stock or at any rate one branch to another. As anthesis progresses an inflorescence continues to

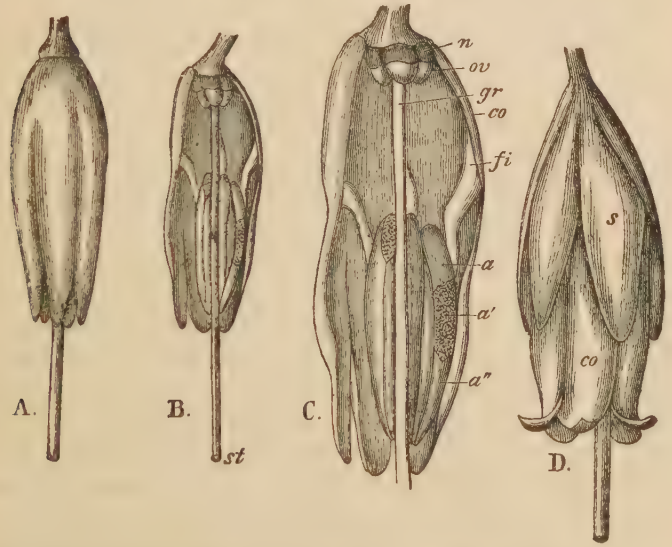


FIG. 274. *Cerinthe alpina*, *Kit.* (after Herm. Müller). *A*. Flower soon after opening. *B*. Do., partly dissected from the side. *C*. Do., more strongly magnified. *D*. Completely expanded flower. (*A*, *B*, *D* × 4; *C* × 7.) *a*, *a'*, *a''*, regions of anthers; *co*, corolla; *fi*, filament; *gr*, style; *n*, nectary; *ov*, ovary; *s*, sepal; *st*, stigma.

elongate, and that part of it bearing fertilized flowers is directed obliquely upwards, while the part bearing unvisited flowers and buds is curved down and rolled inwards. It follows that old flowers in which the corolla is about to fall are either directed obliquely upwards to a slight extent or are placed horizontally, while younger ones are directed obliquely or vertically downwards. The buds are on the rolled-up part of the inflorescence. Humble-bees only cling to flowers facing obliquely or directly downwards, the former being pulled into a vertical position by their weight. The honey-bee only visits flowers directed vertically downwards. All visitors therefore hang on to the bell-shaped corolla from below, and after a visit have to take wing in order to reach another blossom. Their flight is always to another branch or another stock; at least Hermann Müller never saw two flowers on the same inflorescence visited in succession.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (his garden at Lippstadt), the honey-bee and two humble-bees (Bombus agrorum *F.* ☿, and B. terrester *L.* ☿), skg. actively and persistently. Loew (Berlin Botanic Garden), 4 bees, all skg. and po-cltg.—1. Apis mellifica *L.* ☿; 2. Bombus agrorum *F.* ☿; 3. B. lapidarius *L.* ☿; 4. Osmia rufa *L.* ☿. Schulz observed flowers perforated by humble-bees.

1990. C. major L. (Knuth, 'Blütenbiol. a. d. Ins. Capri'; Herm. Müller erroneously describes C. alpina under this name in his 'Alpenblumen.')—This species bears homogamous humble-bee flowers.

Visitors.—I observed (April, 1892) 2 long-tongued bees (Anthophora pilipes *F.*, and A. femorata *Oliv.*) in the crater of the Solfatara. Morawitz noticed the bee Osmia cerinthidis *Mor.*

1991. C. aspera Roth. (Comes, 'Ult. stud.')—Comes describes this species as self-fertile.

613. Echium Tourn.

Mostly protandrous bee-flowers; with nectar secreted by the fleshy base of the ovary, and concealed in the contracted lower part of the funnel-shaped corolla-tube. Sometimes gynodioecious, more rarely gynomonoecious.

1992. E. vulgare L. (Sprengel, 'Entd. Geh.,' pp. 99–101; Herm. Müller, 'Fertilisation,' pp. 418–21, 'Alpenblumen,' p. 262, 'Weit. Beob.,' III, p. 14; Schulz, 'Beiträge,' I; Kirchner, 'Flora v. Stuttgart,' pp. 557–8; Jordan, Ber. D. bot. Ges., Berlin, x, 1892, pp. 583–6; Knuth, 'Grundriss d. Blütenbiol.,' pp. 77–8 'Bloemenbiol. Bijdragen'; Loew, 'Blütenbiol. Floristik,' pp. 391, 399.)—The large blue flowers of this species make the plant extremely conspicuous from a distance, so that it is visited by a very large number of insects, especially bees, hover-flies, butterflies, and moths. In spite of their great difference in size all these visitors are adapted to effect crossing, whether they probe for nectar or come for the pollen. In the protandrous flowers the narrowest part of the corolla surrounds the nectar, and is directed obliquely upwards, its bend corresponding with that of a bee's proboscis. The broadened bases of the five filaments are fused with its basal portion for a distance of 4 mm. At the place where they become free the corolla-tube rapidly widens, so that even the largest humble-bees can conveniently insert their head and a part of their thorax into the flower, while the smaller ones can creep completely into it. The filaments run horizontally together from the place where they become free, and the four lowest ones project 7 mm. beyond the lower margin of the entrance to the flower, forming convenient alighting-rods for humble-bees. Where the uppermost stamen, on the other hand, becomes free, it at once bends down, dividing the access to the nectar-secreting base of the flower into right and left portions, and then runs horizontally to the opening of the flower with the other filaments. The free ends of all the stamens are turned slightly upwards, while the anthers dehisce immediately the flower opens, and their pollen-covered surfaces face in the same direction. It follows that no bee can settle on the flower without getting its under-side dusted with pollen, for the larger humble-bees support their thorax and smaller ones their abdomen on the long stamens, while the ventral surface of a still

smaller bee at least comes into contact with the anther of the short stamen situated in the entrance of the flower. The style runs between the stamens, and its end divides into two short stigmatic branches. When the flower opens it is so short as scarcely to reach the entrance, and is quite straight with its branches closely apposed. In the course of anthesis it elongates till it projects 10 mm. beyond the entrance of the flower, and bends slightly upwards, while its branches diverge. At this stage the style projects further and is bent more strongly upwards than any other part of the alighting platform, so that neither large nor small insects can settle without bringing their ventral surface into contact with one of the stigmatic branches. The cross-pollination brought about in this way is ensured by the projection of the stigma, even if at the time when it matures some pollen remains clinging to the anthers. Jordan points out that it is sometimes effected by insects as they settle, and sometimes as they withdraw and fly away. Schulz observed homogamy in rare cases.

Hermaphrodite flowers are not the only kind found in this species, for stocks very infrequently occur which bear female ones. In these the corolla is much smaller and the style shorter, while the stamens are short and only produce abortive pollen-grains. Between hermaphrodite and female flowers there are also transitional stages, in which one, two, or three stamens are fully developed and the remainder reduced. Schulz states that female stocks are very widely distributed, and sometimes as many as three-quarters of the plants in a particular locality are of this kind. He even found places here and there, e.g. at Cölleda, where nothing but female stocks were to be seen. The size of the female flowers varies considerably, the corolla being 11–14 mm. long in the larger ones, and only 7–9 mm. in the small ones. Schulz often found the female stocks to be remarkably vigorous. He explains the development of female flowers as due to the excessive strain on the supply of food resulting from the production of inflorescences with a very large number of flowers.

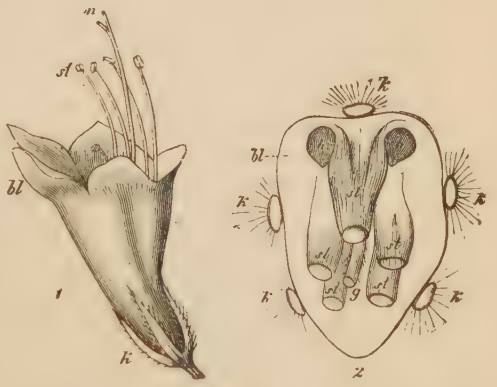


FIG. 275. *Echium vulgare*, *L.* (after Herm. Müller). (1) An older flower, seen from the side (its actual position is horizontal). (2) Basal transverse section of a flower. *bl*, corolla; *f*, style; *h*, nectar-passages; *k*, sepals; *n*, stigma; *st*, stamens.

VISITORS.—Herm. Müller (H. M.) for Westphalia and Thuringia (T.) and Buddeberg (Budd.) for Nassau give the following list.—

A. Coleoptera. *Oedemeridae*: 1. Oedemera virescens *L.*, searching for nectar (H. M.). **B. Diptera.** (*a*) *Conopidae*: 2. Physocephala rufipes *F.*, skg. (H. M.); 3. P. vittata *F.*, do. (H. M.); 4. Sicus ferrugineus *L.*, do. (Budd.). (*b*) *Syrphidae*: 5. Helophilus trivittatus *F.*, po-dvg. (H. M.); 6. Melanostoma ambigua *Fall.*, do. (H. M.); 7. Microdon devius *L.*, do. (Budd.); 8. Rhingia rostrata *L.*, skg. (H. M.); 9. Syrphus arcuatus *Fall.*, po-dvg. (H. M.); 10. S. pyrastri *L.*, do. (H. M.). **C. Hymenoptera.** (*a*) *Apidae*: 11. Andrena albicrus *K.* ♂, skg. (H. M.); 12. A.

fulvicrus *K.* ♂, do. (H. M.); 13. A. hattorfiana *F.* ♂, do. (H. M., T.); 14. A. labialis *K.* ♂, do. (H. M.); 15. Anthidium manicatum *L.* ♂, do. (Budd.); 16. A. oblongatum *Ltr.* ♀, do. (Budd.); 17. Anthophora furcata *Pz.* ♀ and ♂, skg. and po-cltg. (H. M., T.); 18. A. quadrimaculata *F.* ♀ and ♂, freq., do. (H. M., T.); 19. Apis mellifica *L.* ☿, exceedingly freq., skg. (H. M.); 20. Bombus agrorum *F.* ♀ and ☿, skg. (H. M.); 21. B. hortorum *L.* ♀, ☿ and ♂, do. (H. M.); 22. B. hypnorum *L.* ☿, do. (H. M.); 23. B. lapidarius *L.* ♀, ☿ and ♂, do. (H. M.); 24. B. pratorum *L.* ♀, do. (H. M.); 25. B. rajellus *K.* ☿, do. (H. M.); 26. B. sylvarum *L.* ♀ and ☿, skg. and po-cltg. (H. M.); 27. B. terrester *L.* ♀ and ♂, skg. (H. M.); 28. Ceratina albilabris *F.* ♀, do. (Budd.); 29. C. cyanea *K.* ♀, do. (H. M.); 30. Chelostoma nigricorne *Nyl.*, ♂ and ♀, do. (H. M.); 31. Coelioxys conoidea *Klg.* ♀, do. (H. M.); 32. C. quadridentata *L.* ♀ and ♂, freq., do. (H. M.); 33. C. simplex *Nyl.* ♀, do. (H. M.); 34. C. umbrina *Sm.* ♀, do. (H. M.); 35. Diphysis serratulae *Pz.* ♀ and ♂, very common, skg. and po-cltg. (H. M.); 36. Eucera longicornis *L.* ♂, skg. (H. M.); 37. Halictus albipes *F.* ♂, do. (H. M.), ♀ po-dvg. (Budd.); 38. H. cylindricus *F.* ♀ and ♂, skg. (H. M.); 39. H. nitidiusculus *K.* ♀, po-cltg. (H. M.); 40. H. nitidus *Schenck* ♀, skg. (H. M.); 41. H. sexnotatus *K.* ♀, do. (H. M.); 42. H. smeathmanellus *K.* ♀, do. (H. M., T.); 43. Megachile circumcincta *K.* ♀, do., skg. and po-cltg. (H. M.); 44. M. willughbiella *K.* ♂, skg. (H. M.); 45. Melecta luctuosa *Scop.* ♀, do. (H. M., T.); 46. Nomada sexfasciata *Pz.* ♀, do. (H. M.); 47. Osmia adunca *Ltr.* ♀, very common, skg. and po-cltg. (H. M., Budd.); 48. O. aenea *L.* ♀ and ♂, skg. and po-cltg. (H. M.); 49. O. caementaria *Gerst.* ♀, do. (H. M., Budd.), building its cells in hollows in stones, and feeding its young entirely on Echium nectar and pollen; 50. O. fusca *Christ.* ♀, skg. and po-cltg. (H. M.); 51. O. leucomelaena *K.* ♀, po-cltg. (H. M.); 52. O. rufa *L.* ♀, skg. (H. M., Budd.); 53. Prosopis hyalinata *Sm.* ♀, do. (H. M.); 54. Psithyrus barbutellus *K.* ♀, do. (H. M.); 55. P. campestris *Pz.* ♀ and ♂, do. (H. M.); 56. P. rupestris *F.* ♀, do. (H. M.); 57. P. vestalis *Fourcr.* ♀, do. (H. M.); 58. Saropoda bimaculata *Pz.* ♀ and ♂, very common, skg. (H. M.); 59. Stelis breviuscula *Nyl.* ♂, skg. (H. M.); 60. S. phaeoptera *K.* ♀, do. (H. M.). (*b*) *Chrysididae*: 61. Cleptes semiauratus *L.*, skg. (H. M.). (*c*) *Sphegidae*: 62. Ammophila sabulosa *L.* ♀, skg. (H. M.); 63. Crabro patellatus *v. d. L.* ♀ and ♂, skg. (H. M.); 64. Psammophila affinis *K.* ♀, do. (H. M.). (*d*) *Vespidae*: 65. Odynerus parietum *L.* ♂, skg. (H. M.). **D. Lepidoptera.** All skg. (*a*) *Noctuidae*: 66. Plusia gamma *L.*, freq. (H. M., Budd.). (*b*) *Rhopalocera*: 67. Colias hyale *L.* (H. M., T.); 68. Epinephele janira *L.* (H. M.); 69. Hesperia comma *L.* (H. M.); 70. H. sylvanus *Esp.* (H. M.); 71. Lycaena euphemus *Hb.* (Budd.); 72. L. sp. (H. M.); 73. Melitaea cinxia *L.* (H. M.); 74. Pieris brassicae *L.* (H. M.); 75. P. rapae *L.* (H. M., T.); 76. Vanessa urticae *L.* (Budd.). (*c*) *Sphingidae*: 77. Macroglossa stellatarum *L.* (H. M., Budd.); 78. Zygaena lonicerae *Esp.* (H. M., T.).

Müller adds the following note to his list ('Fertilisation,' pp. 420–1).—

'A review of this long list of insects, many of which frequent the flowers of Echium in great numbers, shows that the great majority come seeking honey, and only use the stamens as a landing-place. The females of bees with abdominal collecting-brushes, without any special effort, sweep up pollen with their abdominal brushes, filling them after a few visits. The flower is thus so convenient for them that several of these bees (*Osmia adunca* and *O. caementaria*) resort to it exclusively, both for their own food and for that of their larvae. *Syrphidae* also make frequent use of the pollen, while bees with tibial or femoral collecting-baskets seldom gather it, and all other insects come solely for the sake of the honey.'

Loew observed the following.—

I. In Mecklenburg (M.) and Brandenburg (B.) ('Beiträge,' p. 43).—

A. Diptera. *Tabanidae*: 1. Tabanus rusticus *L.* ♂, skg. (B.). **B. Hymenoptera.** *Apidae*: 2. Anthophora nidulans *F.* ♀ (B.); 3. A. quadrimaculata *F.* ♀ (M.);

4. Bombus distinguendus *Mor.* ♀ and ♂, skg. (M.); 5. B. sylvarum *L.* ☿, do. (M.); 6. Coelioxys tricuspidata *Först.* ♀, do. (M.); 7. Heriades nigricornis *Nyl.* ♀, do. (M.); 8. Megachile argentata *F.* ♀ and ♂, do. (M.); 9. M. centuncularis *L.* ♀, do. (M.); 10. M. maritima *K.* ♂, do. (M.); 11. Osmia adunca *Ltr.* ♀, po-cltg. (M.); 12. O. aurulenta *Pz.* ♀, do. (M.); 13. O. caementaria *Gerst.* ♂, skg. (M.); 14. O. solskyi *Mor.* ♀, po-cltg. (M.); 15. O. bicornis *L.* ♀, skg. (B.); 16. Prosopis confusa *Nyl.* ♀, do. (M.).

II. In Silesia (op. cit., p. 27).—

A. Diptera. (*a*) *Bombyliidae*: 1. Bombylius minor *L.*, skg. (*b*) *Syrphidae*: 2. Syrphus seleniticus *Mg.* **B. Hymenoptera.** (*a*) *Apidae*: 3. Apis mellifica *L.* ☿, skg.; 4. Bombus cognatus *Steph.* ☿, po-cltg.; 5. B. confusus *Schenck* ☿, do.; 6. B. rajellus *K.* ☿, do.; 7. B. sylvarum *L.* ♀, skg.; 8. Coelioxys octodentata *Lep.* ♂, do.; 9. C. punctata *Lep.* ♀, do.; 10. Colletes nasutus *Sm.* ♀ and ♂ skg., ♀ also po-cltg.; 11. Megachile maritima *K.* ♂, skg.; 12. Osmia adunca *Ltr.* ♀ and ♂ do., ♀ do.; 13. O. tridentata *Duf. & Perr.* ♂(?), skg.; 14. Psithyrus rupestris *F.* ♀, do.; 15. Saropoda rotundata *Pz.* ♂, do. (*b*) *Sphegidae*: 16. Bembex rostrata *L.* ♀ and ♂, skg.; 17. Cerceris arenaria *L.* **C. Lepidoptera.** All skg. (*a*) *Hesperidae*: 18. Hesperia comma *L.* (*b*) *Noctuidae*: 19. Plusia festucae *L.*; 20. P. gamma *L.* (*c*) *Rhopalocera*: 21. Aporia crataegi *L.*; 22. Vanessa urticae *L.*

III. In Switzerland (op. cit.), p. 61.—

Two humble-bees (Bombus sylvarum *L.* ☿, skg.? and B. variabilis *Schenck*, var. tristis *Seidl.* ☿, do.) and the hawk-moth Zygaena pilosellae *Esp.*

The following were recorded by the observers, and for the localities stated.—

Knuth (Schleswig-Holstein), 5 bees (1. Apis mellifica *L.* ☿; 2. Bombus agrorum *F.* ♀; 3. B. lapidarius *L.* ♀ and ☿; 4. B. hortorum *L.* ♀, ♂ and ☿; 5. B. rajellus *K.* ♀), a hover-fly (Rhingia rostrata *L.*), and 2 Lepidoptera (Pieris napi *L.*, and Plusia gamma *L.*): all skg. Wüstnei (Alsen), the bee Halictus quadristrigatus *Ltr.* Herm. Müller (Alps), 17 bees and 5 Lepidoptera. von Fricken (Westphalia and East Prussia), the Nitidulid beetle Meligethes tristis *Strm.* Gerstäcker (Berlin), 3 bees—1. Coelioxys quadridentata *L.*; 2. Osmia adunca *Ltr.*; 3. O. spinolae *Schenck.* Alfken (Bremen), 6 bees—1. Coelioxys rufescens *Lep.* ♀ and ♂, skg.; 2. Eriades nigricornis *Nyl.* ♀ and ♂; 3. Halictus morio *F.* ♀; 4. Osmia rufa *L.* ♀; 5. O. adunca *Ltr.* ♀ and ♂; 6. Podalirius bimaculatus *Pz.* ♀. Schmiedeknecht (Thuringia), 2 bees—Osmia adunca *Ltr.*, and O. spinolae *Schenck* (= O. caementaria *Gerst.*). Schenck (Nassau), 5 bees—1. Ceratina cucurbitina *Rossi*; 2. C. cyanea *K.*; 3. Osmia adunca *Ltr.*; 4. O. spinolae *Schenck*; 5. Podalirius bimaculatus *Pz.* Friese, for Hungary (H.), Baden (B.), Bozen (Bz.), Innsbruck (I.), Mecklenburg (M.), and Switzerland (S.), 14 bees—1. Biastes brevicornis *Pz.* ♀, not infreq. (Bz., Siders, H.); 2. Crocisa major *Mor.*, one (H.); 3. C. ramosa *Lep.* (Bz., H.); 4. C. truncata *Pér.* a ♂ (H.); 5. Eucera tricincta *Er.* (M.) (*teste* Konow); 6. E. dalmatica *Lep.* (H.); 7. Osmia adunca *Ltr.*, freq. (B., M., H.); 8. O. claviventris *Ths.* (M., Thuringia); 9. O. insularis *Schmiedekn.* (Mallorca); 10. O. lepelletieri *Pér.*, freq. (I., S.); 11. O. spinolae *Schenck* ♀ (B.) and ♂ (M.); 12. Podalirius crassipes *Lep.* a ♂ (S.); 13. P. quadrifasciatus *Vill.*, not infrequent (Thuringia, H.); 14. P. vulpinus *Pz.* not infreq. (B.), freq. (M.). Frey-Gessner (Switzerland), 2 bees—Osmia rufa *L.*, and O. dalmatica *Mor.* ♀ and ♂. Morawitz (Caucasus), 5 bees—1. Bombus haematurus *Krchb.*; 2. Eucera similis *Lep.*; 3. E. spectabilis *Mor.*; 4. Podalirius raddei *Mor.*; 5. P. tarsatus *Spin.* Smith (England), 2 bees—Ceratina cyanea *K.*, and Megachile argentata *F.* von Dalla Torre (Upper Austria), 3 humble-bees—1. Bombus arenicola *Thoms.*; 2. B. hortorum *L.*; 3. B. senilis *F.* (= B. variabilis *Schmiedekn.*): (Tyrol), 2 bees (Andrena thoracica *F.* ☿, and Nomada lateralis *Pz.* ♀) and 2 humble-bees (Bombus ruderatus *F.*, and B. sylvarum *L.* ♀ and ☿, extremely freq.). Schletterer, for Tyrol and Pola (P.),

9 bees—1. Andrena thoracica *F.*; 2. Bombus agrorum *F.*; 3. B. pomorum *L.*; 4. B. ruderatus *F.*; 5. B. sylvarum *L.*; 6. B. terrester *L.* (P.); 7. Ceratina cucurbitina *Rossi* (P.); 8. Megachile lefeburei *Lep.* (P.); 9. Nomada xanthosticta *K.* Kohl (Tyrol), the fossorial wasp Crabro peltarius *Schreb.* ♀ and ♂. Ducke (Trieste), 3 bees—1. Osmia adunca *Ltr.* ♀ and ♂, freq.; 2. O. notata *F.* ♀, freq.; 3. O. spinolae *Schenck* ♀ and ♂, rare. Hoffer (Steiermark), the bee Rhophites quinquespinosus *Spin.* Dours (Paris), the bee Anthophora femorata *Ltr.* (= Podalirius femoratus *Oliv.*), freq. Heinsius (Holland), 4 humble-bees, skg. (1. Bombus agrorum *F.* ♂ and ☿; 2. B. terrester *L.* ♂; 3. Psithyrus vestalis *Fourcr.*; 4. P. campestris *Pz.* 2 ♂), a short-tongued bee (Halictus sexcinctus *F.* ♂, skg.), 2 hover-flies (Rhingia campestris *Mg.* ♂, skg., and Melanostoma hyalinata *F.* ♂, po-dvg.), and 2 butterflies, skg. (Rhodocera rhamni *L.* ☿, and Pieris rapae *L.* ♀ (Bot. Jaarb. Dodonaea, Ghent, iv, 1892, pp. 108–9). H. de Vries (Netherlands), 5 bees—1. Bombus agrorum *F.* ☿; 2. B. elegans *Seidl.* ♂; 3. B. terrester *L.* ♂; 4. Psithyrus campestris *Pz.* ♂; 5. P. vestalis *Fourcr.* ♂ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875). MacLeod (Flanders), 4 humble-bees, the honey-bee, a short-tongued bee, a hover-fly, and a moth (Plusia sp.) (Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 334–5): (Pyrenees), on the var. *pyrenaica*, numerous long-tongued and some short-tongued bees, also some Lepidoptera, Bombyliids, and hover-flies (op. cit., iii, 1891, p. 310).

1993. E. rosulatum Lange. (Loew, Ber. D. bot. Ges., Berlin, iv, 1886, pp. 153–5.)—The flower mechanism of this species is similar to that of E. vulgare, but the corolla is shaped more like a handbell, while its greater length and the presence of various constrictions render the nectar more inaccessible, so that an insect requires a proboscis 9–10 mm. long in order to reach it.

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

Two humble-bees (Bombus agrorum *F.*, and B. hortorum *L.*) skg. legitimately, and one (B. terrester *L.*) perforating the flowers and stealing nectar. Also 2 po-dvg. hover-flies—Pipiza chalybeata *Mg.*, and Syritta pipiens *L.*

1994. E. italicum L. (=E. altissimum *Jacq.*).—

Visitors.—Friese (South Hungary) observed the bee Eucera dalmatica *Lep.*; and Schletterer (Pola) the rare bee Halictus variipes *Mor.*

614. Lithospermum L.

Flowers feebly protogynous or homogamous; with concealed nectar secreted by the ovary, and hidden in the base of the corolla-tube. Sometimes belong to class **Hh**.

1995. L. arvense L. (Sprengel, 'Entd. Geh.,' p. 88; Herm. Müller, 'Fertilisation,' pp. 417–18, 'Weit. Beob.,' III, p. 16; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 310, 322; Kirchner, 'Flora v. Stuttgart,' p. 560; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 335; Knuth, 'Bloemenbiol. Bijdragen.')—The small inconspicuous flowers of this species are usually white in colour, but Loew says there is also a local blue variety. The corolla-tube is $4\frac{1}{2}$ mm. long and 1 mm. broad, and the short stalks of the five stamens are inserted more than half-way down it. The anthers dehisce introrsely before the flower opens, though Kerner, on the contrary, describes this as feebly protogynous. There are hairs above the anthers which prevent rain from entering the tube. The style is about 2 mm. long, and terminates in two smooth closely apposed lobes of rounded conical shape, below which is an annular swelling beset with stigmatic papillae. This is situated in the middle

of the anthers, so that the entrance of the flower is completely filled, and the proboscis of an insect probing for nectar must force its way between anthers and stigma. If this takes place at the beginning of anthesis, and the proboscis has previously been dusted with pollen, crossing will be effected, and a fresh supply of pollen will adhere to the organ. Soon, however, the anthers dehisce so strongly that the stigma gets covered with pollen, so that autogamy is inevitable. Insect-visits are but few.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth, 2 bees (Apis mellifica *L.* ☿, and Bombus lapidarius *L.* ♀), skg., and a butterfly (Pieris brassicae *L.*). Sprengel also observed the 'common white butterfly.' Herm. Müller.—**A. Diptera.** *Syrphidae*: 1. Rhingia rostrata *L.*; 2. Syritta pipiens *L.* **B. Hymenoptera.** *Apidae*: 3. Apis mellifica *L.* ☿, skg.; 4. Bombus agrorum *L.* ♀, do. **C. Lepidoptera.** *Rhopalocera*: all skg.: 5. Pieris brassicae *L.*; 6. P. napi *L.*; 7. P. rapae *L.* MacLeod (Flanders), a Lepidopterid (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 371).

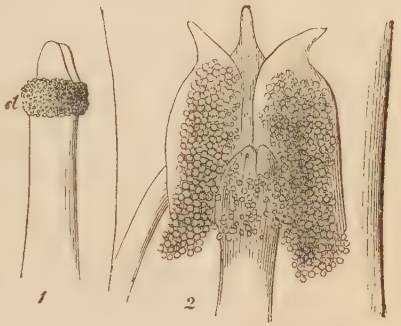


Fig. 276. *Lithospermum arvense*, *L.* (after Herm. Müller). (1) End of the style, taken from a bud (× 36). *st*, stigma. (2) Position of the reproductive organs in the flower.

1996. L. canescens Lehm.—Darwin describes the flowers of this species as either heterostylous or very variable in regard to the length of the style.

1997. L. purpurocaeruleum L. (Kirchner, 'Beiträge,' p. 51; Loew, 'Blütenbiol. Floristik,' p. 282.)—The tolerably large flowers of this species exhibit a similar colour change to that of Pulmonaria, being first purple-red and afterwards blue. Kirchner found the plant to be feebly protogynous in the Swabian Alps, the stigma being mature when the flowers opened, and the anthers dehiscing shortly afterwards. Both organs stand at the same level just within the opening of the cylindrical corolla-tube, 7 mm. above the base of the flower. Loew describes the corolla-tube as 8–9 mm. long, with five radial white longitudinal folds at its entrance corresponding to the hollow scales of some other genera.

Visitors.—Loew observed 2 long-tongued bees (Anthophora pilipes *F.* ♂, and Osmia aenea *L.*), skg., in the Berlin Botanic Garden.

1998. L. officinale L.—

Visitors.—Loew (Berlin Botanic Garden) observed the bee Megachile willughbiella *K.* ♀, skg.; and Schletterer (Pola) saw the bee Halictus variipes *Mor.*

1999. L. angustifolium Michx. (=Batschia longiflora *Pursh*).—Darwin observed cleistogamy in this species.

615. Mertensia Roth.

Flowers with concealed nectar. Dimorphous according to Darwin ('Different Forms of Fls.').

2000. M. maritima S. F. Gray (=Stenhammeria maritima *Reichb.*).—Warming ('Bestövningsmaade,' pp. 5–6) states that the flowers of this species are smaller in Greenland than Norway. The anthers being at the same level as the stigma automatic self-pollination regularly takes place.

The var. *tenella* Th. Fr. was observed in Spitzbergen by Andersson and Hesselman ('Bidrag till Känned. om Spetsbergens o. Beeren Eil. Kärlväxtflora,' p. 17), as well as by Ekstam ('Blütenbiol. Beob. a. Spitzbergen,' p. 8). The odourless flowers are red in the bud, afterwards assuming a blue colour; being homogamous self-pollination is facilitated. The nectar secreted by the hypogynous disk is only protected by slight involutions of the corolla. Many flowers had completed their anthesis by July 13 (1897), and ripe fruits were met with (by Ekstam) on August 8. In Greenland (Sermitdlet Fjord) fruits were observed to be set as early as July 7 (1892) (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlands-exped.,' pp. 46–7).

Visitors.—Ekstam (op. cit.) observed none in Spitzbergen.

2001. M. pulmonarioides Roth (=M. virginica *Link*). (Loew, 'Beiträge,' II, pp. 54–6.)—This is a North American species.

Visitors.—Loew (Berlin Botanic Garden) observed the bee Anthophora pilipes *F.* ♂, skg. legitimately, and small bees (Halictus nitidiusculus *K.*) po-cltg.

616. Myosotis Dill.

Flowers homogamous, generally blue in colour, seldom pink or white; with concealed nectar secreted by the fleshy base of the ovary, and stored at the bottom of the short corolla-tube. Yellow, pocket-like involutions at the entrance of the flower serve both as nectar-guides and nectar-covers. They also compel visitors to insert their proboscis into the base of the flower in such a way as to touch the stigma and anthers. Kerner asserts that the species are heterostylous ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 302).

2002. M. sylvatica Hoffm. (Herm. Müller, 'Fertilisation,' pp. 414–15, 'Weit. Beob.,' III, pp. 16–17; Kirchner, 'Flora v. Stuttgart,' pp. 561–2.)—The corolla-tube of this species is 2–3 mm. long, and the somewhat converging anthers are inserted into it at a higher level than the simultaneously maturing stigma. When the flower opens they dehisce introrsely, so that an insect visitor must insert its proboscis between them and the stigma, touching the two kinds of organs with opposite sides, and effecting crossing if another flower has previously been visited, provided the proboscis is only once inserted. Flies, however, generally do this several times, so that they often bring about self-pollination. Otherwise this is effected automatically by fall of pollen on the stigma. Kerner says that this is not possible at first, on account of the lateral position of the flower, but only later on when it becomes erect. Experiments made by Axell show that autogamy results in complete fertility, and this is also the case with plants automatically self-pollinated on the Dovrefjeld.

Visitors.—Herm. Müller gives the following list.—

A. Coleoptera. (*a*) *Dermestidae*: 1. Anthrenus scrophulariae *L.*, resting on the flower, with its mouth applied to the entrance, but unable to get in. (*b*) *Nitidu-*

lidae: 2. Meligethes sp., creeping about the flowers, but never in the corolla-tube. (*c*) *Telephoridae*: 3. Anthocomus fasciatus *L.*, vainly skg. **B. Diptera.** (*a*) *Conopidae*: 4. Myopa sp., skg. (*b*) *Empidae*: 5. Empis opaca *F.*, skg.; 6. E. vernalis *Mg.*, do. (*c*) *Muscidae*: 7. Anthomyia radicum *L.* ♀ and ♂; 8. Calobata cothurnata *Pz.*, skg.; 9. Chlorops scalaris *Mg.*; 10. Echinomyia sps.; 11. Musca corvine *F.*, skg.; 12. M. domestica *L.*, do.; 13. Opomyza germinationis *L.*, numerous, skg.; 14. Onesia floralis *R.-D.*, skg.; 15. O. sepulcralis *Mg.*, do.; 16. Pollenia vespillo *F.*, do.; 17. Scatophaga merdaria *F.*, do.; 18. S. stercoraria *L.*; 19. Sepsis atriceps *R.-D.*, *in copula* on the flowers; 20. Siphona geniculata *Deg.*, skg. (*d*) *Syrphidae*: 21. Eristalis arbustorum *L.*, freq., skg.; 22. E. sepulcralis *L.*, do.; 23. Rhingia rostrata *L.*, skg.; 24. Syritta pipiens *L.*, very common, skg. **C. Hymenoptera.** *Apidae*: 25. Andrena albicans *K.* ♀, persistently skg.; 26. A. pilipes *F.* ♀, skg.; 27. A. varians *Rossi* ♀, do.; 28. Apis mellifica *L.* ☿, freq., skg.; 29. Megachile fasciata *Sm.* ♂, sunning itself on the flowers; 30. Osmia rufa *L.* ♀, one, skg. **D. Lepidoptera.** *Rhopalocera*: 31. Pieris sp., skg.

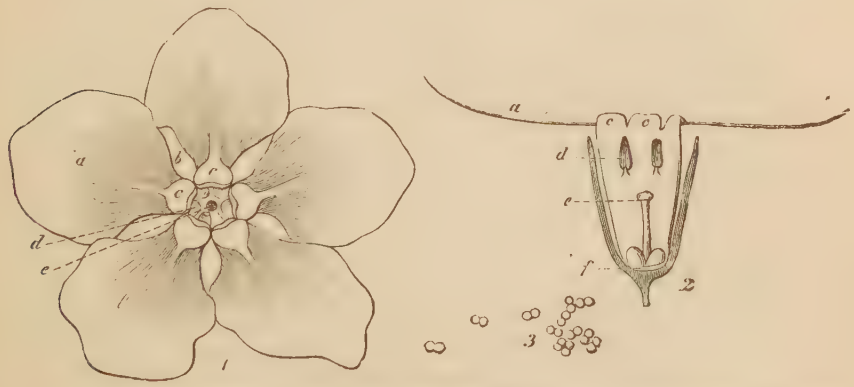


FIG. 277. *Myosotis sylvatica*, *Hoffm.* (after Herm. Müller). (1) Flower seen from above. (2) Do., partly dissected from the side (× 7). (3) Pollen-grains. *a*, bright blue limb of the corolla; *b*, white radial streaks; *c*, yellow centre of the corolla; *d*, stamens; *e*, stigma; *f*, nectary.

The following were recorded by the observers, and for the localities stated.—

Bail (West Prussia), 2 hover-flies (Eristalis sp., and Helophilus sp.) and 2 butterflies (Pieris napi *L.*, and Polyommatus phlaeas *L.*) (Bot. Centralbl., Cassel, ix, 1882). Scott-Elliot (Dumfriesshire), a hover-fly ('Flora of Dumfriesshire,' p. 122).

2003. M. alpestris F. W. Schmidt (=M. sylvatica *Hoffm.*, var. *β alpestris* Koch). (Herm. Müller, 'Alpenblumen,' pp. 259–60.)—The fragrant flowers of this Alpine species are commonly of a more vivid and darker blue than those of lowland species, though paler blossoms also occur as well as small- and large-flowered stocks. (*Cf.* Fig. 278.) Their mechanism agrees with that of M. sylvatica. Crossing by insect-visits is favoured, but should these fail automatic self-pollination takes place. Magnus observed a variety with an excessive number of flowers, and as this remained constant under cultivation continuous autogamy was inferred.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 33 Lepidoptera, 18 flies, a bee, and a beetle. Loew (Switzerland), the hover-fly Melithreptus scriptus *L.* ('Beiträge,' p. 60): (Berlin

Botanic Garden), a hover-fly (Eristalis nemorum *L.*) and 2 bees—1. Apis mellifica *L.* ☿, skg.; 2. Osmia rufa *L.* ♀, persistently skg. Plateau (Ghent Botanic Garden), the honey-bee and Osmia sp. Ekstam (Nova Zemlia), flies.

2004. M. intermedia Link. (Herm. Müller, 'Fertilisation,' pp. 415–16, 'Weit. Beob.,' III, p. 17; Kirchner, 'Flora v. Stuttgart,' p. 562; Knuth, 'Bloemenbiol. Bijdragen.')—In the small, homogamous, sky-blue flowers of this species the stigma is at the same level as the anthers, so that an insect proboscis probing for nectar is even less likely to touch both with the same side than in M. alpestris. The connectives are produced into broad swollen appendages covering the anthers, and preventing an inserted proboscis from taking up pollen to be transferred to the stigma. These two peculiarities ensure crossing by insect-visits to a greater extent than in the preceding species, but should these fail automatic self-pollination regularly takes place.

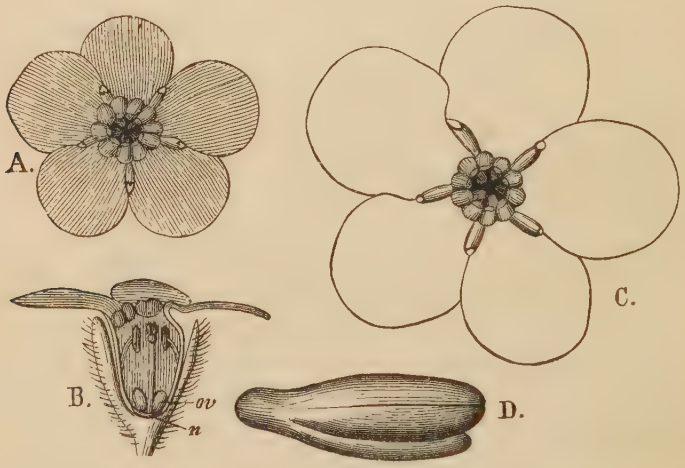


FIG. 278. *Myosotis alpestris*, *F. W. Schmidt*. *A*. Small-flowered dark-blue form. *B*. Do., partly dissected from the side. *C*. Large-flowered paler form. *D*. A stamen before dehiscence. (*A–C* × 7; *D* × 35.) *n*, nectary; *ov*, ovary.

VISITORS.—Herm. Müller gives the following list.—

A. Diptera. (*a*) *Bombyliidae*: 1. Bombylius major *L.*, skg. (*b*) *Muscidae*: 2. Aricia incana *Wiedem.*, freq., skg.; 3. Limnophora sp., skg.; 4. Pollenia vespillo *F.*, skg. (*c*) *Syrphidae*: 5. Ascia podagrica *F.*, skg.; 6. Chrysogaster viduata *L.*, do.; 7. Syritta pipiens *L.*, freq., skg. **B. Hymenoptera.** *Apidae*: all skg.: 8. Andrena albicans *Müll.* ♀; 9. A. fasciata *Wesm.* ♂; 10. A. nana *K.* ♂; 11. A. parvula *K.* ♀, in large numbers; 12. Apis mellifica *L.* ☿, numerous: hanging vertically or obliquely from the flower, it inserts the tip of its tongue with great accuracy into the small opening of the corolla-tube; 13. Sphecodes gibbus *L.* ♀, skg. **C. Lepidoptera.** *Rhopalocera*: 14. Coenonympha pamphilus *L.*, freq., skg.; 15. Pieris napi *L.*, skg.; 16. P. rapae *L.*, do.

The following were recorded by the observers, and for the localities stated.—

Knuth, the honey-bee and two hover-flies, skg. (Eristalis arbustorum *L.*, and Syritta pipiens *L.*). MacLeod (Flanders), a Muscid and the honey-bee (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 338, vi, 1894, p. 371).

2005. M. collina Hoffm. (=M. hispida *Schlecht.*). (Herm. Müller, 'Fertilisation,' p. 416, 'Weit. Beob.,' II, pp. 18–19.)—The mechanism of the minute homogamous, bright blue flowers of this species agrees essentially with that of M. intermedia. The anthers are contained in the short (scarcely 2 mm.) corolla-tube, and converge together over the stigma, upon which they ultimately drop pollen. Should there be insect-visits, however, crossing takes place in the following way, according to Hermann Müller.—The yellow pocket-like involutions of the corolla so narrow the opening of the flower that the proboscis of an insect can only be inserted exactly in the centre. The appendages of the connectives end ¼ mm. below the entrance, but guide the proboscis between them along the axis of the flower, until it inevitably comes into contact with the stigma, and glides over its rounded surface, to which pollen brought from a previously visited flower will adhere, before the nectar is reached. When the proboscis is withdrawn it brushes past the inner surfaces of the anthers, and dusts itself with pollen.

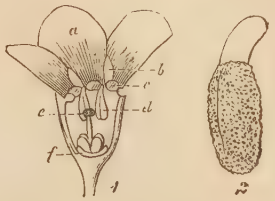


FIG. 279. *Myosotis intermedia*, *Link* (after Herm. Müller). (1) Flower partly dissected from the side (× 7). (2) Lateral view of a stamen (still more strongly magnified), to show the broad outwardly bent appendage of the connective. *a*, bright-blue corolla-lobes; *b*, radial white streaks; *c*, yellow centre of the corolla; *d*, anthers; *e*, stigma; *f*, nectary.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Westphalia), a Muscid (Anthomyia sp.), skg. Borgstette (Mecklenburg), the bee Halictus zonulus *Sm.* ♀, skg. Verhoeff (Norderney), the bee Halictus minutus *K.* ♀, skg. MacLeod (Flanders), a Lepidopterid (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 338). Schletterer (Pola), the Scoliid Scolia hirta *Schr.*

2006. M. versicolor Sm. (Herm. Müller, 'Weit. Beob.,' III, pp. 17–18; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 338–9; Kirchner, 'Flora v. Stuttgart,' pp. 562–3.)—The newly opened flowers of this species are bright yellow in colour, and adapted to cross-pollination: subsequently they become blue, and in this stage automatic self-pollination is inevitable. In the first condition the corolla-tube is only 2 mm. long, and the fully developed style (3 mm. in length) projects beyond the anthers inserted into its upper part, while the mature stigma even protrudes from the flower. As the limb of the corolla changes to sky-blue the corolla-tube elongates until the anthers attain the level of the stigma and deposit pollen upon it.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller, a humble-bee (Bombus agrorum *F.*, only skg. for a short time), 2 bees (Halictus sexnotatus *K.* ♀, skg., and H. zonulus *Sm.* ♀, do.), and 2 hover-flies (Rhingia rostrata *L.*, skg. persistently, and Syritta pipiens *L.*, skg.). MacLeod (Flanders), a bee (Andrena sp.) and a butterfly (Pieris sp.) (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 371). Scott-Elliot (Dumfriesshire), several Muscids and Dolichopodids ('Flora of Dumfriesshire,' p. 123).

2007. M. palustris Lam. (Sprengel, 'Entd. Geh.,' p. 88; Herm. Müller, 'Fertilisation,' p. 416; Knuth, 'Bloemenbiol. Bijdragen.')—The flowers of this species agree in their mechanism with those of M. intermedia, except that they

are larger and possess a corolla-tube 5 mm. long. Kerner states that in the higher mountain stations they are of a deeper blue colour than in the plains. MacLeod observed gynodioecism at Ghent.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth, the hover-fly Syrphus ribesii *L.*, freq., skg. Herm. Müller, an Empid (Empis opaca *F.*, very freq., skg.) and a butterfly (Lycaena icarus *Rott.*, skg.). Sickmann (Osnabrück), the Sapygid Sapyga quinquepunctata *F.* MacLeod (Flanders), the honey-bee, a short-tongued bee, 5 hover-flies, 6 Muscids, a butterfly, and a beetle (Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 335–7). Scott-Elliot (Dumfriesshire), 3 hover-flies and 2 Muscids ('Flora of Dumfriesshire,' p. 121).

2008. M. cespitosa Schultz. (MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 337.)—The mechanism of this species is similar to that of M. palustris, though the flowers are smaller. Automatic self-pollination is possible.

2009. M. parsiflora Mikan. (Schulz, 'Beiträge, II, p. 115.)—The homogamous flowers of this species are bright-blue, rarely white in colour, and arranged in scanty cymes. The style projects as far as the middle of the anthers, so that automatic self-pollination is inevitable. Cross-pollination by means of insects is possible.

Visitors.—Schulz observed 2 flies, including Rhingia rostrata *L.*

2010. M. pyrenaica Pourr. (=M. sylvatica *Hoffm.*, according to the *Index Kewensis.*).—

Visitors.—MacLeod (Pyrenees) observed 2 bees, 5 Lepidoptera, a Bombyliid, 2 Syrphids, and 7 Muscids (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 311–12).

617. Cordia L.

Darwin ('Different Forms of Flowers,' p. 117) describes dimorphism, but the differences between the stamens, pistils, and pollen-grains of the two forms are very small.

LXXII. ORDER *CONVOLVULACEAE* JUSS.

Literature.—A. Peter, 'Convolvulaceae,' in Engler and Prantl, 'D. nat. Pflanzenfam.,' IV, 3 a, p. 9.

Flowers usually brightly coloured, and adapted to the visits of insects of the most various kind. In many cases they remain open only for a day or a few hours, then closing permanently. The edge of the withering corolla curls inwards and helps the corolla-tube to protect the ovary. Many exotic species possess extra-floral nectaries which keep insects unsuited for the transfer of pollen away from the flowers (e. g. species of Ipomoea, Pharbitis, Calonyction, and Quamoclit).

618. Convolvulus L.

Homogamous, more rarely protandrous or protogynous flowers with concealed nectar; or homogamous Lepidopterid flowers. Nectar secreted by the base of the ovary. Occasional gynodioecism. On account of the narrow tubular nectar-

passages Kerner describes the blossoms of Convolvulus, like those of Gentiana (*cf.* p. 100), as 'revolver flowers.'

2011. C. arvensis L. (Sprengel, 'Entd. Geh.,' pp. 107–8; Herm. Müller, 'Fertilisation,' pp. 423–4, 'Weit. Beob.,' III, p. 6; Kirchner, 'Flora v. Stuttgart,' pp. 548–9; Burgerstein, Ber. D. bot. Ges., Berlin, vii, 1889; Schulz, 'Beiträge,' II, p. 110; MacLeod, Bot. Jaarb. Dodonaea, Ghent, i, 1889, p. 110, iii, 1891, p. 310, v, 1893, pp. 328–9; Schilberszky, Bot. Centralbl., Cassel, Beiheft iii, 1893, pp. 447–8, Bot. Centralbl., Cassel, lxii, 1895, pp. 342–6, lxiii, 1895, pp. 160–1; Loew, 'Blütenbiol. Floristik,' pp. 277–8; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 106, 164, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 238, 'Bl. u. Insekt. a. Helgoland'; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The fragrant flowers of this species close during bad weather and at night. Burgerstein says that at Vienna and Prague they open from 7–9 a.m., closing again about 5 p.m. At Ruppin, according to Warnstorf, they open 9–10 a.m., and close between 6 and 7 p.m. He describes the pollen-grains as white in colour, ellipsoidal, delicately tuberculate, up to 88 μ long and 56 μ broad.

Anthesis lasts a day. The funnel-shaped corolla is either reddish with five longitudinal white streaks, or entirely white (var. *hololeucus* Knuth): its base is yellow. Nectar is secreted by the orange-yellow base of the ovary, and covered by the broadened lower ends of the filaments, leaving only five narrow nectar-passages. Where the filaments touch they are closely beset with small stiff projections, preventing the passage of an insect's proboscis, which must be inserted into one of the five narrow passages in order to reach the nectar. As the stamens surround the style and their anthers dehisce extrorsely, the latter must be touched by any large insect sucking nectar, and as the two stigmatic branches project beyond the stamens, and spread out their papillose inner surfaces above them, these must necessarily first come into contact with visitors. The first flower visited by an insect will be self-pollinated as its visitor withdraws, while the second will be crossed. Should insect-visits fail, automatic self-pollination can take place towards the end of anthesis when the flower bends down and the corolla drops, so that pollen falls upon the stigma. And it may also be effected in a still vigorous upright flower by elongation of a stamen till its anther is applied to the stigma.

There are various forms of blossom. At Stuttgart, for example, Kirchner observed a small-flowered autumn form, with stamens so short that the yellowish-brown anthers were almost sessile. These remained sterile, for there were scarcely any insect-visits, and the anthers were too far from the stigma to render autogamy possible. Schilberszky noticed the same form at Buda-Pesth, with numerous transitions to female flowers. Besides this arrested form, produced by the action of a fungus, Burgerstein observed two others at Vienna and Prague, one with a large corolla, long stamens and violet anthers, and the other with a corolla of medium size, shorter stamens, and white anthers.

Schulz describes two forms differing in their mechanism. One of these is small-flowered, chiefly visited by bees, and homogamous or slightly protogynous, its stigmatic branches interlocking with the pollen-covered anthers, so as to make

automatic self-pollination the rule. The other form is large-flowered, chiefly visited by humble-bees, and strongly protandrous with the stigmatic branches always projecting beyond the anthers, thus making cross-pollination necessary. The latter form, provided with red or violet-red nectar-guides above the nectar-passages, was also observed by Kirchner in the Tyrol and MacLeod in Belgium. Indeed MacLeod found no less than four distinct forms growing on the dunes at Blankenberg.—(1) The one described above after Sprengel and Hermann Müller. (2) A large-flowered form 35 mm. in diameter, with the corolla of a bright reddish colour above, and a broad red wavy band surrounding its central and lower yellowish part. (3) A small-flowered form similarly coloured and marked, with two curved appendages at the base of each filament, though these may be reduced or entirely absent. The small stiff projections on the edges of the filaments are ill-developed, besides which the filaments may be interwoven so as to close the nectar-openings. (4) A female form with short stamens and reduced anthers.

Schulz also observed, though rarely, gynomonoecism and gynodioecism.

According to E. Heckel (quoted in Ludwig's 'Lehrbuch d. Biologie,' p. 30), a smut-fungus (Thecaspora hyalina *Fingerh.* = T. capsularum *Desm.*) induces floral dimorphism. In the most diverse parts of France this is associated with the presence of a spider, Thomisius onustus *Walck.*, which destroys the insect visitors. Obviously plants which are on this account forced to resort to self-fertilization will become weakened by in-breeding and more exposed to the attacks of the parasitic fungus that causes modification of the flowers.

The investigations of Schilberszky do not support Heckel's view. Besides normal macrandrous flowers he distinguished abnormal micrandrous ones, it being a case of heterandry, though of purely pathological or teratological nature.

In the micrandrous flowers Schilberszky found the conidial form of a smut-fungus on the angular nectary and anthers, not only of open flowers, but also of many buds, even those in a very immature condition, which would be impossible if Heckel's theory were correct. If, continues Schilberszky, the supposed weakening of plants by in-breeding were a fact, all the flowers on the same stock would necessarily be of the same kind. But this is not the case, for normal and infected ones are borne on the same stock, especially if there are many branches. Infection takes place when the seed begins to germinate, for it is then often surrounded by a perfect crust of germinating spores. The mycelium then penetrates into the growing tissue of the stem, and ultimately makes its way along the peduncles to the flower-buds, where it develops first conidia and then chlamydospores.

With reference to the presence of the spider Thomisius onustus in Convolvulus, Schilberszky remarks that it lies in wait for insects inside the flowers of various Hungarian plants. He concludes that its presence has nothing to do with causing the appearance of micrandrous flowers in this species.

Warnstorf also found the conidial form of Thecaphora capsularum on many anthers of convolvulus at Neu-Ruppin. In this case all the pollen-grains are destroyed, while the anthers are of a dirty-brown colour and are borne on short filaments at the bottom of the corolla. Warnstorf has so far only noticed the infestation on the small-flowered variety, but since he has found many hundred

stocks of this with flowers possessing normal anthers, he is of opinion that it is impossible to regard the small size of the flowers as due to the action of the fungus.

Visitors.—Herm. Müller gives the following list.—

A. Coleoptera. (*a*) *Cerambycidae*: 1. Leptura livida *L.*, dvg. pollen and anthers. (*b*) *Curculionidae*: 2. Spermophagus cardui *Stev.*, penetrating into the base of the flower. (*c*) *Nitidulidae*: 3. Meligethes, very common in the nectar-passages. (*d*) *Oedemeridae*: 4. Oedemera virescens *L.*, po-dvg. (*e*) *Telephoridae*: 5. Malachius viridis *F.*, po-dvg. **B. Diptera.** (*a*) *Bombyliidae*: 6. Bombilius canescens *Mik.*, skg. (*b*) *Empidae*: 7. Empis livida *L.*, extremely freq., skg., inserting its proboscis into the 5 nectar-passages successively. (*c*) *Muscidae*: 8. Oliviera lateralis *Pz.*, skg.; 9. Sepsis, freq. in the nectar-openings; 10. Ulidia erythrophthalma *Mg.*, running about in the flowers and settling on the nectar-openings. (*d*) *Syrphidae*: 11. Eristalis arbustorum *L.*, skg. and po-dvg.; 12. Helophilus floreus *L.*, do.; 13. Melithreptus scriptus *L.*, po-dvg.; 14. M. taeniatus *Mg.*, do.; 15. Syrphus balteatus *Deg.*, do.; 16. S. nitidicollis *Mg.*, do. **C. Hemiptera.** 17. Nabis, skg. **D. Hymenoptera.** (*a*) *Apidae*: 18. Andrena cingulata *F.* ♀, skg.; 19. Apis mellifica *L.* ☿, very common, skg. and po-cltg.: in order to suck it creeps along the funnel-shaped corolla into the base of the flower and gets its head and back dusted with pollen, after having first brushed against the stigma with the same regions; 20. Chelostoma campanularum *K.* ♂, skg.; 21. Halictus leucozonius *Schr.* ♀, po-cltg.; 22. H. longulus *Sm.* ♀, do; 23. H. malachurus *K.* ♀, do.; 24. H. morio *F.* ♀, skg. and po-cltg.; 25. H. nitidiusculus *K.* ♂, skg.; 26. H. smeathmanellus *K.* ♀, do.; 27. H. tetrazonius *Klg.* ♀, do.; 28. H. villosulus *K.*, po-cltg.; 29. Panurgus banksianus *K.* ♂, skg. (*b*) *Formicidae*: 30. Lasius niger *L.* ☿, resting in the nectar-openings and trying, without success, to force its head into them. (*c*) *Sphegidae*: 31. Entomognathus brevis *L.* ♂, skg. **E. Lepidoptera.** All skg. *Rhopalocera*: 32. Argynnis latonia *L.* (Bavarian Oberpfalz); 33. Epinephele janira *L.*; 34. Pieris napi *L.*; 35. P. rapae *L.* **F. Thysanoptera.** 36. Thrips, very numerous.

Alfken noticed 3 bees at Bremen (1. Halictus morio *F.* ♀ and ♂; 2. Prosopis communis *Nyl.* ♀; 3. P. hyalinata *Sm.* ♂) and records the following 9 bees for various localities.

(Bozen), 1. Systropha curvicornis *Scop.*, freq., skg. and po-cltg., the sides of its abdomen thickly covered with pollen; 2. Biastes brevicornis *Pz.* (the parasite of 1), rare: (Trieste), 3. Halictus cephalicus *Mor.*, ♀ and ♂, skg.; 4. H. morio *F.* ♀ and ♂; 5. H. subauratus *Rossi*; 6. H. leucozonius *Schr.* ♀, very common; 7. H. morbillosus *Krchb.* ♀ and ♂; 8. H. scabiosae *Rossi*, very common, skg. and po-cltg., the most frequent pollinator on the Austrian coast; 9. Prosopis sp.

Knuth gives the following.—

I. For Schleswig-Holstein.—**A. Diptera.** *Syrphidae*: all po-dvg.: 1. Eristalis sp.; 2. E. tenax *L.*; 3. Helophilus pendulus *L.*; 4. Syrphus balteatus *Deg.* **B. Hymenoptera.** *Apidae*: all skg. and po-cltg.: 5. Apis mellifica *L.*; 6. Bombus sp.; 7. B. terrester *L.*

II. For the high land of Helgoland.—**A. Diptera.** *Muscidae*: 1. Coelopa frigida *Fall.*, skg. without effecting crossing; 2. Lucilia caesar *L.*, do. (11. 7. '95). **B. Orthoptera.** 3. Forficula auricularia *L.*, dvg. the flowers.

The following were observed by Loew in Silesia ('Beiträge,' p. 26).—

A. Diptera. (*a*) *Bombyliidae*: 1. Anthrax maura *L.*, skg.; 2. Systoechus sulphureus *Mikan.*, do. (*b*) *Stratiomyidae*: 3. Odontomyia viridula *F.*, skg. (*c*) *Syrphidae*: 4. Chrysotoxum festivum *L.*, skg. **B. Hymenoptera.** *Apidae*: 5. Systropha spiralis *Oliv.* ♂ and ♀, skg., the tufts of hair on the abdomen of the ♀ thickly covered with

pollen; both sexes taking up night-quarters in the funnel-shaped corolla: this bee seems to be a regular visitor in many localities (A. Karsch, 'Insektenwelt,' p. 272). **C. Lepidoptera.** (*a*) *Noctuidae*: 6. Plusia gamma *L.*, skg. (*b*) *Rhopalocera*: 7. Argynnis dia *L.*; 8. Pieris brassicae *L.*, skg.

The following were recorded by the observers, and for the localities stated.—

H. de Vries (Netherlands), the honey-bee (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875). MacLeod (Flanders), the honey-bee and 2 butterflies (Pieris sp.) (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 329); (Pyrenees), a hover-fly (op. cit., iii. 1891, p. 310). Ducke (Trieste), the bee Osmia papaveris *Ltr.* ♀. Schletterer (Pola), the bee Prosopis hyalinata *Sm.*, var. subquadrata *Först.* Friese (on this species and C. sepium), 2 bees—Systropha curvicornis *Scop.* (Hungary), and S. planidens *Gir.*, freq. (Hungary, Austria, Thuringia, and Switzerland).

2012. C. sepium L. (=Calystegia sepium *R. Br.*). (Sprengel, 'Entd. Geh.,' p. 106; Delpino, 'Alcuni appunti di geografia botanica,' p. 17; Bot. Ztg., Leipzig, xxvii, 1869, p. 794; Buchanan White, J. Bot., London, New Ser., ii, 1873; Herm. Müller, 'Fertilisation,' pp. 424–5, 'Weit. Beob.,' III, pp. 6–7, 'Alpenblumen,' p. 257; Kirchner, 'Flora v. Stuttgart,' p. 548; Vuyck, Ned. Kruidk. Arch., Nijmegen, 2. Ser., 1. Deel, 1894, pp. 1–45; Knuth, 'Blütenbiol. Herbstbeob.,' 'Bloemenbiol. Bijdragen'; MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, pp. 370–1; Burgerstein, Ber. D. bot. Ges., Berlin, vii, 1889, p. 370; Focke, Kosmos, Stuttgart, xiv, 1884, p. 291; Schwarz and Wehsarg, Jahrb. wiss. Bot., Leipzig, xv, 1884; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1894.)—This species bears large homogamous diurnal hawk-moth flowers, white in colour, and odourless. In spite of their conspicuousness they are but little frequented by insects. They close during rainy weather, but remain open on moonlight nights. Their mechanism agrees essentially with that of C. arvensis. Nectar is secreted and concealed as in the latter, the broad bases of the five filaments surrounding it so as to leave only five narrow nectar-passages. Above this the filaments lie close together, and bend towards the middle of the flower, closely surrounding the style. The stigmatic branches project beyond the extrorsely dehiscing anthers, so that insects probing for nectar must first touch the stigmas and then the pollen-covered anthers, thus cross-pollinating the second flower visited.

Should insect-visits fail, automatic self-pollination may be effected by the bending down or fall of the corolla.

According to Warnstorf's account the white anthers are extrorse, and usually at a lower level than the stigma, more rarely at almost the same height. Their inner sides are beset with droplets of viscid matter as in C. arvensis. Some or all the anthers may be abortive, quite apart from the possible influence of the fungus Thecaphora hyalinata *Fingerh.* (=T. capsularum *Desm.*) (*cf.* Magnus, Verh. bot. Ver., Berlin, xxxviii, 1896, p. 80). This would appear, however, to cause the degeneration of the anthers in many cases where its conidial form infests them. Such flowers are smaller than the others, and their dirty-brown anthers are usually borne on short filaments. The pollen-grains are white in colour, rounded, closely beset with small tubercles, possessing germinating processes, and 88–93 μ in diameter.

Visitors.—The characteristic visitor and legitimate pollinating agent is the convolvulus hawk-moth (Sphinx convolvuli *L.*), upon which the plant is so closely

dependent that its distribution seems to be determined by that of the moth. In some localities the insect is tolerably rare, and pollination being correspondingly infrequent the plant would die out if it did not propagate vegetatively. In this connection Vuyck points out that there are stems of two kinds, the ordinary twining ones, and others that do not twine. The latter are generally lower branches, but they may be produced higher up, and then grow right down to the ground, sometimes attaining a very great length, and sending out roots here and there.

Buchanan White says that the convolvulus hawk-moth is rare in England, and that the plant rarely sets fruit. In Scotland, where the moth does not occur, the convolvulus is seldom met with in the wild state. T. H. Corry states that in North Ireland this species is far commoner than C. arvensis, and the convolvulus hawk-moth is comparatively abundant. Hermann Müller adds that for the area of distribution of the plant to extend somewhat outside that of the moth would be intelligible, as there are other insects that play the part of pollinators, though to a subordinate degree.

The hawk-moth in question has been observed by Delpino (Florence), Herm. Müller (Westphalia), Alfken (Bremen), and Knuth (Kiel). Herm. Müller (H. M.) and Buddeberg (Budd.) add the following list.—

A. Coleoptera. *Nitidulidae*: 1. Meligethes sp., uncommonly numerous, po-dvg. and forcing its way into the nectar-passages (H. M.). **B. Diptera.** (*a*) *Empidae*: 2. Empis sp., inserting its proboscis into the nectar-passages (H. M.); 3. E. tessellata *F.*, skg. (H. M.). (*b*) *Syrphidae*: 4. Rhingia rostrata *L.*, skg. and po-dvg. (H. M.). **C. Hymenoptera.** *Apidae*: 5. Chelostoma nigricorne *Nyl.* ♂, freq., skg. (H. M.); 6. Halictus cylindricus *F.* ♂, do. (H. M.); 7. H. zonulus *Sm.* ♀, po-cltg. (H. M.); 8. Megachile centuncularis *L.* ♂, skg. (H. M.); 9. Stelis aterrima *Pz.* ♂, do. (Budd.). **D. Thysanoptera.** 10. Thrips, very numerous (H. M.).

Vuyck gives the following list of species (determined by Ritzema).—

A. Hymenoptera. *Apidae*: 1. Bombus terrester *L.* ♀; 2. B. hypnorum *L.* ♂; 3. B. agrorum *F.* ♀; 4. Megachile centuncularis *L.* ♀; 5. Halictus cylindricus *F.* ♀; 6. Vespa rufa *L.* ♀. **B. Diptera.** (*a*) *Syrphidae*: 7. Eristalis tenax *L.* ♀ and ♂; 8. E. arbustorum *L.* ♂; 9. E. horticola *Deg.* ♀; 10. Syrphus balteatus *Deg.* ♂ and ♀; 11. S. ribesii *L.* ♂ and ♀; 12. S. pyrastri *L.* ♀; 13. S. corollae *F.* ♀; 14. Helophilus pendulus *L.* ♀; 15. Rhingia campestris *Mg.* ♀. (*b*) *Empidae*: 16. Empis livida *L.* ♂ and ♀. (*c*) *Muscidae*: 17. Sarcophaga albiceps *Mg.* ♂; 18. Lucilia cornicina *Fabr.* ♂; 19. Anthomyia sp. ♀.

The humble-bees mentioned, especially Bombus agrorum *F.*, play a considerable part in pollination, which is also effected by the po-dvg. hover-flies, though these usually bring about autogamy. The remaining insects, to which the earwig (Forficula auricularia *L.*) may be added, are unbidden guests.

The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel), the beetle Meligethes as an unbidden guest. MacLeod (Flanders), 2 hover-flies, an Empid, and a short-tongued bee (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 371). Scott-Elliot (Dumfriesshire), 2 humble-bees and an Empid ('Flora of Dumfriesshire,' p. 120). Ducke (Trieste), the bee Eucera (Macrocera) malvae *Rossi*.

2013. C. Cantabrica L.—

Visitors.—Schletterer observed 5 bees at Pola.—

1. Andrena nana *K.*; 2. Ceratina cucurbitina *Rossi*; 3. Crocisa major *Mor.*; 4. Halictus variipes *Mor.*; 5. H. villosulus *K.*

2014. C. Soldanella L. (=Calystegia Soldanella *R. Br.*).—The plants of this species examined by MacLeod on the dunes at Blankenberg were gynodioecious. The mechanism of the hermaphrodite flowers is similar to that of C. arvensis. They are rose-coloured, with five longitudinal white streaks, and their diameter is 40–50 mm. The style terminates in two thick papillose stigmatic lobes, and the relative length of it and the stamens is very variable. Sometimes the stigma projects as much as 5 mm. beyond the anthers so that automatic self-pollination is impeded; and sometimes it is at a lower level, so that autogamy is inevitable. There are numerous intermediate stages between these two extremes.

The female flowers possess a long style and short stamens, of which the anthers are the same in form as in hermaphrodite blossoms, but do not dehisce and dry up from the base. Both kinds of flower are fertile.

Visitors.—The following were recorded by the observers, and for the localities stated.—

MacLeod, a small bee and the earwig (dvg. the anthers), as unbidden guests. H. de Vries (Netherlands), 2 humble-bees—Bombus agrorum *F.* ☿, and B. terrester *L.* ☿ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875).

2015. C. siculus. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 230, 333.)—Kerner states that in this Mediterranean species the style is produced into two long filiform stigmas. One of these is vertical and forms a direct continuation of the style, while the other diverges at an angle of 60°, and is disposed like a barrier at the entrance of the flower. The stamens are applied to the style, and when the corolla expands their anthers lie on the upright stigma, though when dehiscence takes place autogamy is at first hindered, for the clefts of the anthers are turned outwards, so that insects probing for nectar remove the pollen and transfer it to the transverse stigma of the next flower visited. Later on the anthers shrivel up, and get covered all over with pollen, which is unavoidably transferred to the upright stigma, thus rendering autogamy ultimately possible.

2016. C. tricolor L.—The flowers of this Mediterranean species, which is cultivated in Germany, are ephemeral. Kerner says that they open about 7–8 a.m., closing again about 6–8 p.m. Comes ('Ult. stud.') describes them as self-fertile.

619. Ipomoea L.

2017. I. purpurea Roth. (Burgerstein, Ber. D. bot. Ges., Berlin, vii, 1889; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 336.)—Cultivated plants of this species examined by Burgerstein and Kerner were protogynous. The stamens are usually applied to the style, and being of different lengths the anthers do not lie side by side, but collectively afford a relatively long surface where pollen is present. At first automatic self-pollination is hindered, not only on account of protogyny, but also because the stigmas project beyond the anthers. Darwin and Kerner, however, say

that it takes place later on, for the stamens elongate so that the two or three longest touch the stigma. Kerner adds that it is in any case inevitable, for when the corolla withers it rolls up and presses the anthers against the stigma.

2018. I. Pes-tigridis L. (Dillenius, Bot. Ztg., Leipzig, xxi, 1863, p. 310.)—This species bears cleistogamous flowers.

620. Cuscuta L.

Small inconspicuous flowers, aggregated into clusters or spikes; usually homogamous; with concealed nectar, secreted by the base of the ovary. Kerner says that autogamy is brought about by convergence of the filaments. Cleistogamy frequent.

2019. C. Epithymum Murr. (including C. trifolii *Bab.*). (Herm. Müller, 'Weit. Beob.,' III, pp. 7–8; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 330; Kirchner, 'Flora v. Stuttgart,' p. 550; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 106–7.)—The flowers of this species are whitish or reddish, and usually pentamerous, though in some cases 4-, 3-, or 2-merous. The nectar is protected from rain by five or a smaller number of scales which bend together over the ovary. The lobes of the corolla are at first directed obliquely upwards, but subsequently spread out horizontally. The stamens mature at the same time as the stigmas, and are considerably longer than the two styles (especially in the variety *trifolii* Bab.). The latter are generally irregularly curved, and their upper stigmatic region is of a purple colour. Cross-pollination by means of insects is favoured, for anthers and stigmas are generally touched by opposite sides of their proboscis. But autogamy is easy should insect-visits fail, for the stigmas lie in the line of fall of the pollen.

Warnstorf describes the whitish or reddish flowers as feebly protandrous. The yellow anthers are brown at the side and dehisce laterally before the purple stigmatic branches attain their full maturity and project from the open corolla, while at the same time the stamens and corolla-lobes curve outwards. Autogamy is thus at any rate rendered very difficult. The pollen-grains are of golden-yellow colour, ellipsoidal, closely tuberculate, up to 31 μ long and 18–20 μ broad.

The flowers of plants observed by me in the island of Amrum opened slightly or not all; the automatic self-pollination which took place was followed by the setting of abundant fruits.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller, 2 fossorial wasps—Crabro elongatus *v. d. L.*, occasional, skg., and Philanthus triangulum *F.* ♂, freq., skg. Kohl (Tyrol), the true wasp Polistes gallica *L.*

2020. C. europaea (=C. major *Gilib.*). (Kirchner, 'Flora v. Stuttgart,' p. 550; Cosson et Germain, 'Atlas flore,' pl. XIV, Paris, 1882; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 330–1; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, 391; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The flowers of this species are usually reddish in colour, and, though somewhat larger than those of the last species, Kirchner describes their mechanism as similar. Kerner found

automatic self-pollination to take place in open flowers, as well as pseudocleistogamously in closed ones during bad weather.

Warnstorf describes the pollen-grains as resembling those of the last species, but rather larger, i.e. about 35 μ long and 22 μ broad.

621. Calonyction Choisy.

Darwin describes the flowers as self-sterile.

622. Dichondra Forst.

2021. D. repens Forst.—The flowers of this species are inconspicuous, green, and sometimes cleistogamous (Justs bot. Jahresb., Leipzig, xix, (1891) 1894, p. 424).

623. Mina Cerv.

2022. M. lobata Cerv. (Mattei, Nuovo Giorn. bot. ital., Firenze, xxii, 1890, pp. 290–5.)—Mattei describes the flowers of this species as adapted to cross-pollination by birds.

624. Quamoclit Tourn.

Species of this genus are ornithophilous.

LXXIII. ORDER *SOLANACEAE* JUSS.

Literature.—Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 106; R. von Wettstein, 'Solanaceae,' in Engler and Prantl's 'D. nat. Pflanzenfam.,' IV, 3 b, p. 8.

Flowers partly belong to class **Po** (Solanum), partly to **C** (Lycium), **Hh** (Atropa, Scopolia), and **L.** (Nicotiana). Nectar is secreted below the ovary. The flowers are protogynous or homogamous, and crossing is usually secured or favoured by the projection of the stigma, while automatic self-pollination is generally rendered possible towards the end of anthesis by alteration in position of the reproductive organs or the flowers themselves.

625. Lycium L.

Flowers homogamous; with concealed nectar, secreted by the ovary, and stored in the base of the corolla-tube.

2023. L. vulgare Dun. (=L. barbarum *L.*). (Herm. Müller, 'Fertilisation,' pp. 426–7, 'Weit. Beob.,' III, pp. 23–4; Kirchner, 'Flora v. Stuttgart,' p. 565; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 108–9, 164: 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 238; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 366.)—In this species the lighter throat of the dull-violet corolla is marked with dark-violet lines serving as nectar-guides. The corolla-tube is 7–10 mm. long, and its upper end broadens like a funnel, afterwards passing into a limb 16–22 mm. in diameter. The inside is smooth, but the throat is lined with thick woolly hairs which protect the nectar against rain and unbidden guests. The stigma and stamens mature simultaneously, and the filaments and style are usually of the same length, but the latter may be bent upwards so as to take the stigma away from the anthers. As a rule, however, it is in immediate contact with them, so that

insect-visits may bring about self- and cross-pollination with equal ease. Should these fail autogamy is inevitable.

Kerner has described short-styled flowers in which subsequent growth of the corolla for about ½ cm. brings the anthers into contact with the stigma, so that autogamy takes place.

FIG. 280. *Lycium vulgare*, *Dun.* (after Herm. Müller). (1) Flower seen directly from the front. (2) Do., partly dissected from the side. *a*, nectar-cover; *st*, stigma.

I observed the following mechanism in long-styled flowers, especially those from the neighbourhood of Kiel.—The style is at first somewhat longer than the stamens, and almost always bent downwards, while the stamens are bent upwards, thus separating the mature stigma and the pollen-covered anthers. Bees when visiting the flowers climb up the style and stamens to the opening of the corolla-tube touching first the stigma and then the anthers, and thus effecting cross-pollination. Later on, when the flowers are already beginning to lose their violet colour, the style and filaments straighten out, while the latter elongate to some extent. Stigma and anthers are thus brought into contact, so that automatic self-pollination takes place.

VISITORS.—Herm. Müller observed the honey-bee and 2 humble-bees (Bombus agrorum *F.* ♀, and B. lapidarius *L.* ♀) in Westphalia, and his son the following in Thuringia.—

A. Diptera. *Syrphidae*: 1. Syrphus balteatus *Deg.*, po-dvg. **B. Hymenoptera.** *Apidae*: 2. Anthophora aestivalis *Pz.* ♂ skg., ♀ skg. and po-cltg.; 3. A. quadrimaculata *Pz.* ♀ and ♂ in large numbers, skg.; 4. Apis mellifica *L.* ☿, skg.; 5. Bombus agrorum *F.* ☿, do.; 6. B. rajellus *K.* ♀ and ☿, skg. and po-cltg.; 7. B. sylvarum *L.* ♀, skg.; 8. B. tristis *Seidl.* ♀, do.; 9. Eucera longicornis *L.* ♂ do., ♀ skg. and po-cltg.; 10. Melecta luctuosa *Scop.* ♂, skg.

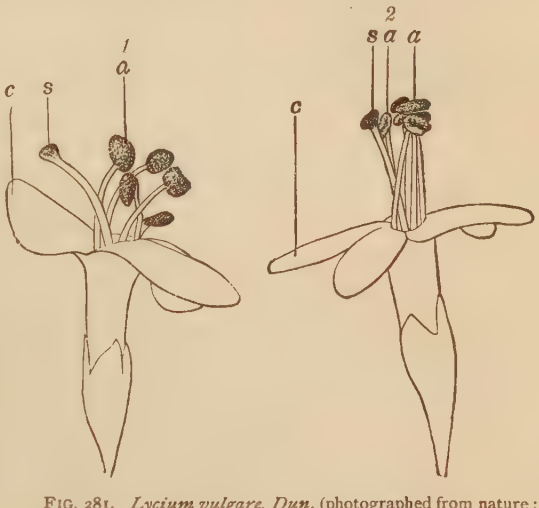


FIG. 281. *Lycium vulgare*, *Dun.* (photographed from nature; × 3). (1) Flower in the first stage (cross-pollination): the filaments with their dehisced anthers are directed upwards, and the style with its mature stigma downwards. (2) Do., in the second stage (self-pollination): anthers and stigma are brought so near together that automatic self-pollination is brought about by direct contact. *a*, anthers; *c*, corolla; *s*, stigma.

To bring the flowers into their natural position they must be supposed rotated through 90° to the left.

Alfken and Leege (L.) give the following list for Juist.—

A. Diptera. (*a*) *Muscidae*: 1. Nemoraea radicum *F.* (*b*) *Syrphidae*: 2. Pipizella virens *F.* **B. Hymenoptera.** (*a*) *Apidae*: 3. Bombus distinguendus *Mor.* ☿, po-cltg. and skg.; 4. B. hortorum *L.*; 5. B. lucorum *L.* ☿ and ♂; 6. B. muscorum *F.* ♀ and ♂; 7. B. terrester *L.* ☿ and ♂; 8. Podalirius vulpinus *Pz.* ♀, rare. (*b*) *Chrysididae*: 9. Cleptes nitidulus *F.* ♀, rare. **C. Lepidoptera.** *Noctuidae*: 10. Plusia chrysitis *L.*, once (L.).

The following were recorded by the observers, and for the localities stated.—

Knuth (North Frisian Islands), the honey-bee, 5 humble-bees (1. Bombus agrorum *F.*; 2. B. cognatus *Steph.*; 3. B. lapidarius *L.*; 4. B. pratorum *L.*; 5. B. terrester *L.*), some Anthophilids, and a butterfly (Pieris sp.), all skg.: (Rügen), the bee Podalirius aestivalis *Pz.* ♀. Friese gives 4 parasitic bees—1. Crocisa major *Lep.* (Bordeaux, *teste* Pérez); 2. C. ramosa *Lep.* (Hungary); 3. C. scutellaris *F.* (Merseburg in Germany); 4. C. truncata *Pér.*, a ♀ (Hungary).

626. Solanum L.

Homogamous to protogynous pollen flowers; sometimes, perhaps, with juicy basal tissue.

2024. S. tuberosum L. (Sprengel, 'Entd. Geh.,' p. 129; Herm. Müller, 'Fertilisation,' pp. 425–6; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 339; Kirchner, 'Flora v. Stuttgart,' p. 566; 'Bloemenbiol. Bijdragen.')—Kerner says that the white or pale-violet flowers of this species droop at night, owing to bending of the peduncles, and raise themselves again during the day. In the diurnal position the peduncle is approximately horizontal, so that the plane of the corolla-limb is about vertical. According to Kerner, the flowers are open between 6–7 a.m., and 2–3 p.m., but some observed by me remained open all day. The five yellow anthers converge to form a cone projecting straight out of the flower, and surrounding the style, which projects beyond it, bending more or less downwards. The anthers dehisce by terminal pores, and anything striking against them causes a little pollen to fall out.

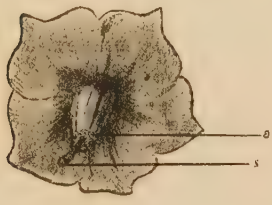


FIG. 282. *Solanum tuberosum, L.* (from nature). Flower seen from the front. *a*, anther-pores; *s*, stigma.

Owing to the position of the stigma, it is first touched by insect visitors, so that cross-pollination is favoured. But, on account of the lack of nectar and scanty yield of pollen, visits are few and automatic self-pollination is necessary. Kerner says that this is effected by folding of the corolla, any pollen clinging to which may be transferred to the stigma; while Herm. Müller states that the downward curve of the style is often strong enough to bring the stigma into the line of fall of the pollen.

Some varieties are self-sterile (Tinzmann), other cultivated forms self-fertile (Woodstock, Kidney, Grampian, and so forth). Of other kinds, some never bear flowers (Ashleaf), while in others the flower-buds fall off without opening (International); sometimes individual flowers open, but they and the buds fall off almost at once (Snowflake), or the flowers may open, but produce no seeds on account of the absence of pollen (Early Rose, Beauty of Hebron), and this is true for still other cases where abundant pollen is produced (King of Potatoes). (Justs bot. Jahresber., Leipzig, viii, (1880) 1883, p. 161.)

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel, on flowers that were mostly protogynous), the po-dvg. hover-fly Syrphus balteatus *Deg.*, and the beetle Meligethes: (Helgoland), 2 po-dvg. Muscids—Coelopa frigida *Fall.*, and Lucilia caesar *L.* Herm. Müller, 2 hover-flies—Eristalis

tenax *L.*, and Syritta pipiens *L.* MacLeod (Flanders), the beetle Meligethes, and a butterfly (Pieris brassicae *L.*), trying to suck.

2025. S. Dulcamara L. (Sprengel, 'Entd. Geh.,' p. 129; Delpino, 'Ult. oss.,' II, p. 295; Herm. Müller, 'Weit. Beob.,' III, pp. 20–2, 'Alpenblumen,' p. 266; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 339; Kirchner, 'Flora v. Stuttgart,' pp. 566–7; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 109, 'Bloemenbiol. Bijdragen.')—The blossoms of this species are homogamous, faintly fragrant, and marked with violet veins. Hermann Müller considers them to be deceptive flowers, while Delpino refers them to the Borago type, thus placing them among the bee flowers. (*Cf.* Vol. I, p. 19.) The anthers make up a cone, and are borne on short stiff filaments, darkly coloured externally. These project vertically from the concave receptacle, which is of a blue-black colour, and shines as if it were covered with a thin layer of fluid. The receptacle is encircled by capitate projections, green with white margins, and placed in pairs at the bases of the corolla-lobes. They, like the receptacle, look damp and are regarded by Hermann Müller as pseudo-nectaries. Observation has shown that flies actually first visit these projections and the shining receptacle, testing them with their proboscis-lobes, and then go to the stigma and the pollen-yielding tips of the anthers. When this procedure is repeated in several flowers cross-pollination is brought about.

Delpino's view, on the other hand, is supported by the observations of Hoffer (Kosmos, Stuttgart, xvi, 1885), who regards the projections at the base of the petals as actual nectaries. My own chemical examination of the flowers affords further evidence in the same direction. (*Cf.* Leucojum aestivum *L.*)

Warnstorff describes the pollen-grains as white in colour, very small, rounded or ellipsoidal, smooth, about 15 μ long and 10–12 μ broad.

Visitors.—Hoffer records the following, sometimes represented by 30 to 40 individuals visiting the same shrub simultaneously, and all to some extent skg.—

A. Hymenoptera. (*a*) *Apidae*: 1. Apis mellifica *L.* ☿; 2. Bombus agrorum *F.* ☿; 3. B. confusus *Schenck* ☿; 4. B. hortorum *L.* ☿; 5. B. hypnorum *L.* ☿; 6. B. lapidarius *L.*; 7. B. pratorum *L.* ☿; 8. B. terrester *L.*; 9. Osmia sp. (*b*) *Vespidae*: 10. Vespa sylvestris *Scop.* ☿, casual. **B. Diptera.** *Syrphidae*: 11. Rhingia rostrata *L.*, po-dvg.; 12. Volucella bombylans *L.* **C. Lepidoptera.** *Rhopalocera*: 13. Argynnis paphia *L.*

Hoffer expressly states that the humble-bees mentioned not only search for pollen, but also for fluid at the base of the corolla, and that the butterflies touch the green projections with their proboscis.

The following were recorded by the observers, and for the localities stated.—

Knuth (North Germany, after long and repeated watching), po-dvg. hover-flies (Syritta pipiens *L.*, and Eristalis tenax *L.*) and po-cltg. bees (Apis mellifica *L* ☿, and Bombus terrester *L.* ☿), so that the flowers actually appear to be adapted to the two kinds of guest. von Fricken (Westphalia and East Prussia), the Nitidulid beetle Pria dulcamarae *Ill.* (also by Redtenbacher at Vienna) and the Curculionid beetle, Cionus solani *F.* Herm. Müller (Alps), a Bombus, a Syrphus, and a Pieris. MacLeod (Pyrenees), a Muscid (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 312).

2026. S. nigrum L. (Sprengel, 'Entd. Geh.,' p. 129; Herm. Müller, 'Fertilisation,' p. 426, 'Weit. Beob.,' III, p. 23; Kirchner, 'Flora v. Stuttgart,' p. 567; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 240; Knuth, 'Bl. u.

Insekt. a. d. nordfr. Ins.,' pp. 109, 164, 'Bloemenbiol. Bijdragen.')—The homogamous nectarless flowers of this species are directed vertically or obliquely downwards, and close at night. The corolla is usually of a pure white colour, but in some cases its lobes are tipped with blue, and not infrequently a narrow blue line runs down the middle of each lobe to the throat, which is then commonly of an orange-yellow. Hermann Müller regards this coloration as perhaps the beginning of adaptation to cross-pollination by means of flies. The tips of the corolla-lobes are reflexed, and the cone of anthers projects in the direction of the floral axis. The stigma protrudes a little beyond this cone, and pollen escapes from the terminal pores of the anthers when the flower is vigorously shaken. Insect visitors climb up from below on the erect somewhat curly hairs covering the short stiff filaments.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Sprengel, bees: 'They struck vigorously against the anthers, so that pollen fell out, and little white balls of this were to be seen on their hind-legs.' Knuth, bees (Apis, Anthophora sp., Bombus agrorum *F.*, and B. terrester *L.* ♀). Herm. Müller, 2 po-dvg. hover-flies—Melithreptus scriptus *L.*, and Syritta pipiens *L.* Buddeberg, 2 po-dvg. hover-flies—Ascia podagrica *F.*, and Syritta pipiens *L.* MacLeod (Flanders), the hover-fly Syritta (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 371).

2027. S. rostratum Dun. (Herm. Müller, Kosmos, Stuttgart, xii, 1883.)—In the flowers of this species the style is turned to the right or left. (For a fuller description *cf.* Vol. I, p. 107.)

627. Physalis L.

Flowers protogynous; with concealed nectar secreted at the base of the ovary, and stored at the bottom of the corolla-tube. Described as 'revolver flowers' by Kerner.

2028. P. Alkekengi L. (Sprengel, 'Entd. Geh.,' p. 127; Kirchner, 'Flora v. Stuttgart,' p. 569; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 366.)—The protogynous dirty-white flowers of this species are either pendulous or directed obliquely downwards. The lobes of the corolla are spread out flat, and marked with green veins serving as nectar-guides, besides which there is a circle of green spots above the insertions of the stamens. In the bottom of the corolla-tube there is a small quantity of nectar, protected from unbidden guests by hairs which line the tube at the bases of the filaments. Kerner describes five grooves in the corolla, which abut against the woolly filaments in the centre of the flower so that tubular passages are formed. ('Revolver flowers.') The pollen-covered sides of the anthers are so disposed at the opening of the flower that they must be touched by insects probing for nectar.

Kirchner states that the stigma is mature when the flower opens, at which time it projects about 4 mm. beyond the still undehisced anthers. The stamens are at first curved outwards and their anthers dehisce extrorsely. Later on they approach the stigma, which still projects beyond them, and as this remains receptive automatic self-pollination can now easily take place by fall of pollen. Kerner describes a subsequent growth of the corolla-tube, by which the anthers are brought up to the stigma and autogamy effected.

628. Nicandra Adans.

Flowers with concealed nectar, secreted by the base of the ovary.

2029. N. physaloides Gaertn. (Sprengel, 'Entd. Geh.,' p. 126; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 217.)—The whitish bell-shaped flowers of this species possess a bright-blue corolla-limb. Kerner says they open about 11–12 in the morning, closing again about 3–4 p.m. The filaments bend into a semicircular curve, bringing the anthers into contact with the stigma and thus automatically effecting self-pollination. The stigma withers and turns brown an hour after it is pollinated, the style falls off at the same time, and the corolla fades. Sprengel states that the bases of the anthers are thickly clothed with hairs serving as nectar-covers. The nectar-guides are in the form of five dark-blue blotches at the base of the corolla, alternating with the filaments and situated immediately above the nectar-covers.

Visitors.—In the Garden of the Kiel Ober-Realschule I saw (10.9.'97) honey-bees which crawled completely into the flowers to suck the nectar, and effected cross-pollination.

629. Atropa L.

Protogynous humble-bee flowers; with nectar secreted at the base of the ovary, and concealed in the lowest contracted part of the bell-shaped corolla.

2030. A. Belladonna L. (Herm. Müller, 'Weit. Beob.,' III, pp. 24–6; Kirchner, 'Flora v. Stuttgart,' pp. 569–70; Knuth, 'Bloemenbiol. Bijdragen'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 305.)—In this species the limb and ventricose part of the corolla are coloured dirty-brown red, and its lower part dirty yellow-green. The measurements of the bell correspond in size and shape to a medium-sized humble-bee. The flowers are directed obliquely downwards, horizontally, or it may be upwards, so that their interior is not always protected from rain. Small unbidden insect guests are kept away from the nectar by strong erect hairs which cover each filament for a length of 4 mm. At the same level as the uppermost part of this barrier the corolla is thickly lined by small stiff erect hairs.

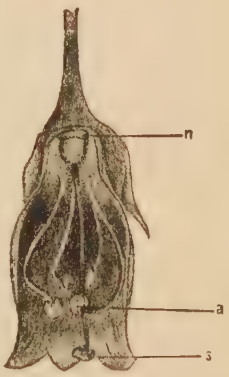


Fig. 283. *Atropa Belladonna*, *L.* (from nature). Flower after removal of half the calyx and corolla. *a*, anthers; *n*, nectary; *s*, stigma.

The stigma projects considerably beyond the stamens, and is mature at the beginning of anthesis, while its position is such that humble-bees creeping into the flower must at once touch it, for the style is slightly bent downwards, and its stigma-bearing end turns slightly upwards. The anthers are at this stage still closed. They lie within the corolla-tube, for the filaments are curved inwards. Later on they dehisce and become covered all over with pollen, while at the same time the filaments straighten to some extent. But they remain more or less curved inwards, so that the stigma continues to project beyond them, and is first touched by insect visitors. Cross-pollination is thus ensured.

As the style with its stigma lies in the lower part of the bell, the latter is

always touched by the under-side of visitors, so that the upper anthers have scarcely anything to do with cross-pollination, but on the other hand are useful for autogamy, which may take place, as a last resort, by the fall of pollen, should insect-visits fail.

Warnstorf describes the pollen-grains as white in colour, rounded polyhedral, beset with lines of delicate papillae, and on an average 50 μ in diameter.

Kerner has observed a change of position between the anthers and stigma, the latter occupying the middle of the flower in the first change of anthesis, while the unripe anthers are apposed to the corolla. During the second stage these positions are reversed. I have examined the flowers to see whether this is actually the case, but am not able to confirm Kerner's description. Kerner adds that the style falls off and the corolla withers an hour after pollination.

Visitors.—Buddeberg gives the following list for Nassau.—

A. Hymenoptera. *Apidae*: all skg.: 1. Andrena gwynana *K.* ♀; 2. Anthophora furcata *Pz.* ♀; 3. Apis mellifica *L.* ☿, numerous; 2. Bombus pratorum *L.*, very common; 5. Cilissa leporina *Pz.* ♂; 6. Halictus cylindricus *F.* ♀, freq.; 7. H. leucopus *K.* ♀, in large numbers; 8. H. malachurus *K.* ♀, very numerous; 9. Megachile centuncularis *L.* ♀, in large numbers, po-cltg. **B. Thysanoptera.** 10. Thrips, numerous, penetrating to the nectar.

The following were recorded by the observers, and for the localities stated.—

Knuth, the honey-bee and 2 humble-bees—Bombus agrorum *F.* ☿, and B. terrester *L.* ☿, both skg. Herm. Müller (Münster), the honey-bee, skg., and Thrips. Loew (Berlin Botanic Garden), 2 humble-bees—Bombus lapidarius *L.* ☿, and B. terrester *L.* ☿, both skg. Plateau (Ghent), the honey-bee.

630. Mandragora L.

Flowers protogynous; with concealed nectar, secreted at the base of the ovary.

2031. M. officinarum L. (=M. vernalis *Bertol.*). (Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.'; Loew, 'Blütenbiol. Floristik,' p. 265; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 279.)—In this Mediterranean species the flowers smell like nightshade and are directed upwards. Kerner says that the lobes of the corolla close together at night and during rainy weather. The flowers lie close to the ground. Loew describes the corolla as of a dull-bluish colour inside, beset with peculiar glandular villous projections and veined with yellow-green externally. The nectar is protected from unbidden guests by thick tufts of hair above the bases of the filaments. Kerner says that a change of position takes place between the stigma and anthers. At first the former occupies the centre of the flower, while the stamens with the unripe anthers lie against the corolla. Two days later the style has bent to the side, bringing the stigma to the corolla, while the stamens with their pollen-covered anthers now occupy the middle of the flower. (*Cf.* Hyoscyamus, Atropa, and Scopolia.)

Visitors.—Loew saw the honey-bee, po-cltg., in the Berlin Botanic Garden ('Beiträge,' II, p. 48).

631. Iochroma Benth.

2032. I. tubulosa Benth. (Delpino, 'Altri appar. dicog. recent. oss.,' p. 60.)—Delpino describes this Mexican species as protogynous, with persistent stigmas.

Visitors.—Delpino says that these are possibly humming-birds.

2033. I. macrocalyx Miers. (Lagerheim, Ber. D. bot. Ges., Berlin, ix, 1891, pp. 348–51.)—

Visitors.—Lagerheim states that these are humming-birds.

632. Scopolia Jacq.

Protogynous humble-bee flowers; with nectar secreted by an annular disk below the ovary.

2034. S. carniolica Jacq. (=S. atropoides *Bercht. et Presl*, and Hyoscyamus Scopolia *L.*). (Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.,' p. 18; Kerner, 'Nat. Hist. Pl., Eng. Ed. 1, II, p. 305; Loew, 'Blütenbiol. Floristik,' p. 284; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The pendulous bell-shaped flowers of this species are of a brown colour externally, with yellow veins, and pale-yellow internally. Loew describes them as about 25 mm. long and 15 mm. broad. The capitate stigma projects beyond the anthers. Kerner says that the stigma and anthers change places as in Mandragora.

Warnstorf describes the pollen-grains as white in colour, rounded tetrahedral, smooth, up to 50 μ in diameter.

Visitors.—Loew (Berlin Botanic Garden) observed a bee with rust-red covering of hairs (Andrena fulva *Schr.* ♀) creeping right into the flowers and skg.

633. Hyoscyamus L.

Homogamous humble-bee flowers; with nectar secreted by the base of the ovary, and concealed in the corolla-tube.

2035. H. niger L. (Sprengel, 'Entd. Geh.,' pp. 124–5; Herm. Müller, 'Fertilisation,' p. 427; Kirchner, 'Flora v. Stuttgart,' p. 571; Ludwig, Bot. Centralbl., Cassel, viii, 1881, p. 89; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 305, 306.)—The flowers of this species are directed obliquely downwards. The feebly zygomorphous corolla is of a dirty pale-yellow colour, with violet nectar-guides. The filaments are covered with hairs above their insertions, and apply themselves to the downwardly bent style. At their bases are three nectar-passages blocked by hairs. As the stigma projects beyond the anthers, cross-pollination by insects is favoured. Kerner says that the anthers are at first situated about 7 mm. below the stigma, but the corolla grows so as to bring them to the same level by the evening, with the result that autogamy takes place. He adds that stigma and anthers change places, as in Mandragora, Scopolia, and others.

In fully fruiting plants of the variety *b. agrestis* Veit., Ludwig noticed that the last flowers on the inflorescence and its branches were reduced, the lower of these being cleistogamously autocarpous, while the terminal ones were represented by vestigial calyces, either empty or completely sterile.

Warnstorf describes the pollen-grains as white in colour, ellipsoidal, densely tuberculate, about 44 μ long and 36 μ broad.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Sprengel, humble-bees. Knuth, 3 humble-bees, all skg.—1. Bombus agrorum *F.* ☿; 2. B. lapidarius *L.* ☿; 3. B. terrester *L.* ☿. Herm. Müller, the small bee Halictus cylindricus *F.* ♀, po-dvg. Scott-Elliot (Dumfriesshire), a humble-bee ('Flora of Dumfriesshire,' p. 124).

2036. H. albus L. (Knuth, 'Blütenbiol. Beob. a. d. Ins. Capri,' p. 11; Comes, 'Ult. stud.')—In this species the yellowish-white corolla projects for 2 cm. from the villous sticky calyx, which is 1·5 cm. long. The stigma is receptive when the flower opens, at which time the anthers of uppermost five stamens dehisce and pollinate it. The remaining stamens develop successively, and in doing so approximate themselves to the stigma. Automatic self-pollination is therefore inevitable, and Comes states that it is effective.

634. Petunia Juss.

2037. P. violacea Lindl.—Darwin describes this species as self-sterile.

2038. P. nyctaginifolia Juss. (Comes, 'Ult. stud.')—Comes states that this species is infertile if insect-visits fail.

635. Nicotiana L.

Protogynous or homogamous flowers belonging to class **C** or **L**: with nectar secreted by the base of the ovary, and stored in the corolla-tube.

2039. N. Tabacum L. (Kirchner, 'Flora v. Stuttgart,' pp. 572–3; Knuth, 'Bloemenbiol. Bijdragen.')—In this species the corolla is 50–70 mm. long: its upper part is bell-shaped, with a throat 10 mm. in diameter, and rose-coloured with a darker middle line on each of the expanded lobes. The corolla-tube is about 30 mm. long and 5 mm. broad. A considerable part of it is filled with the abundant nectar. The lower parts of the filaments are fused with the corolla-tube, and these parts are covered with soft hairs.

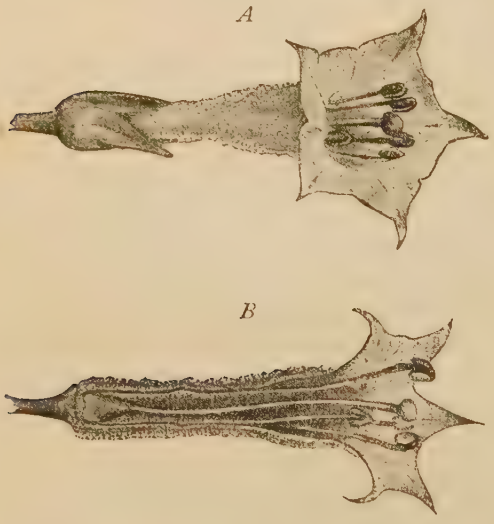


FIG. 284. *Nicotiana Tabacum*, *L.* (from nature). *A*. Flower seen from the side. *B*. Do., partly dissected.

When the flower opens the stigma is mature, while the anthers either dehisce simultaneously, or later, according to the variety. The relative length of stamens and style also differs in different varieties. One of the five anthers is always situated below the stigma, and at a tolerably lower level; while the other four are either all at the same height as the stigma (or one somewhat lower) or two are higher and two at the same level.

Cross-pollination by insects is only favoured in the feebly protogynous flowers, or in homogamous ones when the stigma projects beyond the anthers. Automatic self-pollination is easily possible and generally inevitable. Kerner found that autogamy was effected, as in Hyoscyamus, by elongation of the corolla for almost ½ cm.

Visitors.—In the Kiel Botanic Garden I observed (29. 8. '96) the hawk-moth Macroglossa stellatarum *L.*, skg. Also, in the Garden of the Kiel Ober-Realschule, several honey-bees creeping into the flowers and remaining there for some seconds, so that they probably were able to suck some nectar, and might have effected cross-pollination.

2040. N. rustica L. (Sprengel, 'Entd. Geh.,' p. 125; Kirchner, 'Flora v. Stuttgart,' p. 573; Focke, Kosmos, Leipzig, vi, 1879–80, p. 473; Comes, 'Ult. stud.')—The corolla of this species is yellowish-green with a short tube. The filaments bend over the ovary to the style, but diverge from it higher up. Their lower parts are clothed with soft hairs, which protect the nectar from rain, and leave only five narrow passages to it. Comes describes the species as self-fertile.

Focke observed that humble-bees visited the hybrid N. rustica × N. paniculata, stealing the nectar by perforating the corolla, but they took no notice of the parent species N. rustica.

636. Physochlaina G. Don.

2041. P. orientalis G. Don. (Loew, 'Blütenbiol. Beiträge,' II, pp. 50–2.)—The dull-violet net-veined corolla of this species is a gradually widening tube of 18–20 mm. long, 4 mm. broad below, and 12 mm. above. The anthers protrude from its throat, and the style projects 6 mm. beyond them. Nectar is secreted by a swelling at the base of the ovary. The length of the style and the marked protogyny ensure crossing by insect visitors.

Visitors.—Loew (Berlin Botanic Garden) observed 2 bees, po-cltg.—Apis mellifica *L.* ☿, and Halictus cylindricus *F.* ♀.

637. Datura L.

Homogamous moth flowers; with nectar secreted by the base of the ovary, and concealed between the roots of the filaments.

Fig. 285. *Datura Stramonium*, *L.* (from nature). Flower partly dissected from the side, and somewhat reduced.

2042. D. Stramonium L. (Sprengel, 'Entd. Geh.,' pp. 122–3; Schulz, 'Beiträge,' I, pp. 73–4; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 212–13; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Kirchner, 'Flora v. Stuttgart,' pp. 571–2; Knuth, 'Bloemenbiol. Bijdragen.')—Kerner states that the flowers of this species close periodically, and open between 7 and 8 p.m. According to Kirchner, anthesis lasts for only one day. The flowers possess a well-marked, disagreeable musky odour, and when they are freshly opened this is stronger in the evening than

during the day. They close in dull weather by folding the funnel-shaped corolla. As night flowers they possess no nectar-guides, and are generally quite white in colour, sometimes with a reddish or bluish tinge. The corolla-tube is 55 to 65 mm. long, and broadens out into a limb. The lower parts of the filaments are fused with the corolla-tube by their narrow posterior edges, and their anterior margins are broadened out in such a way that their edges touch. In this way are bounded five long tubular nectar-passages. ('Revolver flowers.') The inner sides of the filaments are beset with short upwardly directed hairs. Stigma and anthers are at about the same level. As the flowers are tolerably upright, automatic self-pollination can take place if insect-visits fail, and when the corolla closes this is inevitable. Schulz states, however, that the stigma sometimes projects beyond the anthers. He was unable to detect nectar in the flowers.

Warnstorf describes the pollen-grains as white in colour, of irregular rounded polyhedral shape, and on an average 56 μ in diameter.

Visitors.—I observed only the beetle Meligethes, freq.

638. Nierembergia Ruiz et Pav.

2043. N. linariaefolia R. Grah. (=N. filicaulis *Lindl.*). (Francke, Inaug.-Dissert., Halle, 1883.)—Francke describes this species as protogynous. The anthers roof over the stigma.

639. Saracha Ruiz et Pav.

2044. S. viscosa Link. (Francke, Inaug.-Dissert., Halle, 1883.)—Francke describes this species as protogynous, but autogamy is ultimately possible.

LXXIV. ORDER *SCROPHULARINEAE* R. BR.

Literature.—Herm. Müller, 'Fertilisation,' pp. 429–65, 'Alpenblumen,' pp. 303–7; Knuth, 'Grundriss d. Blütenbiol.,' p. 79; R. von Wettstein, 'Scrophulariaceae,' in Engler and Prantl's 'D. nat. Pflanzenfam.,' IV, 3 b, pp. 46–7.

In this corner the brightly coloured corolla makes the flowers conspicuous, and this is enhanced by their aggregation into racemose inflorescences. Yellow and red predominate, while many tropical species are scarlet. Variations of colour are found in some instances, most strikingly in Linaria. The flowers of L. virgata *Desf.*, for example, are generally purple, and those of L. reflexa *Desf.* yellow, but in the mountains these are white (Wettstein). Most species of Verbascum bear pollen flowers, in those of the remaining genera nectar is secreted at the base of the ovary, or in Pentstemon at the bases of the filaments. With reference to concealment of nectar the following flower classes are represented in the order.—**C** (Veronica); **H** (Digitalis, Linaria, Euphrasia, Rhinanthus, Melampyrum, Bartsia, Pedicularis); **L** (Rhinanthus alpinus *Koch*); **F** (Tozzia alpina *L.*).

Hermann Müller distinguishes the following four groups.—

(1) Short-tubed open flowers (Verbascum, Veronica), with freely projecting stamens and pistil, which insect visitors usually touch at random. The stigma generally matures, however, before the anthers. The pollinators are bees and flies.

(2) Shortly bell-shaped, widely opened, brownish flowers (Scrophularia), with abundant easily visible nectar, in which stigma and stamens mature in succession, and are touched by insect visitors from below. These are chiefly wasps.

(3) Flowers with a long corolla-tube, open (Digitalis) or closed (Antirrhinum, Linaria), into which visitors introduce themselves entirely or largely, and touch the stamens and stigma with their upper-side. The pollinators are the larger bees.

(4) Flowers with a narrow corolla-tube (Tozzia, Euphrasia, Rhinanthus, Melampyrum, Pedicularis), with an upper lip sheltering the anthers, and a lower lip serving as a platform for insect visitors, which are dusted with the smooth powdery pollen. The forms with the shortest corolla-tubes are pollinated by flies; those with tubes of medium length by bees and flies; and those with long tubes almost exclusively by humble-bees.

In all species the stigma is first touched by insect visitors, so that cross-pollination is ensured, and this is rendered certain by dichogamy in many cases. Automatic self-pollination often takes place should insect-visits fail. In some species insect-visits and consequent crossing are so perfectly provided for that autogamy does not take place.

640. Verbascum Tourn.

Partly pollen flowers, partly flowers with nectar, sparingly secreted in small drops on the inner sides of the petals.

In my opinion the hairs on the filaments serve to increase the conspicuousness of the flowers, at least when their colour differs from that of the petals. But, as Delpino points out, that they also act as holdfasts for insects climbing over the flowers. Kerner says they are devoured by insect visitors, and Hermann Müller that they are licked by these.

In many cases conspicuousness is enhanced by the different colour of the anthers. But this end is chiefly brought about by aggregation of the flowers into elongated inflorescences.

2045. V. thapsiforme Schrad. (Herm. Müller, 'Alpenblumen,' p. 267; Kirchner, 'Flora v. Stuttgart,' p. 575; Schulz, 'Beiträge'; Maury, Bull. soc. bot., Paris, xxxiii, 1886, pp. 529–36; Knuth, 'Bloemenbiol. Bijdragen'; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The golden-yellow flowers of this species are aggregated into elongated inflorescences, and are devoid of nectar and nectar-guides. They vary from feebly protogynous to homogamous. The corolla remains expanded even during rain, and its diameter is about 40 mm. Its lowest lobe serves as an alighting platform, is larger than the four others, depressed in the middle, and about 20 mm. broad. The three upper stamens are beset with white hairs and somewhat bent upwards: the two lower ones project about 4 mm. more out of the flower, and their anthers dehisce longitudinally on the side turned towards the style. The flowers are nearly vertical, and the style is beneath all the five stamens. Its end is somewhat bent upwards, and the stigma projects about 4 mm. beyond the two lower stamens, so that it is first touched by the larger insect visitors, and cross-pollination necessarily results. This is also favoured by feeble protogyny, and Kirchner asserts that automatic self-pollination never takes place.

Warnstorf describes the pollen-grains as orange-yellow in colour, ellipsoidal, densely tuberculate, 37–40 μ long and 25–7 μ broad.

In this species (and V. Thapsus *L.*, V. phlomoides, *L.*, V. pulverulentum *Vill.*, V. Lychnitis *L.*, V. Blattaria *L.*, and V. blattarioides *? auct.*), according to Maury, the anthers dehisce and touch the stigma when the flowers open. This does not, however, result in fertilization, for the stigmatic papillae are not yet developed. At this time, too, the conducting tissue of the style is very dense, offering great resistance to the penetration of pollen-tubes, and the ovules are immature. Pollination becomes effective later on, when it is effected by insect visitors, or as the result of contact between the pollen-covered anthers and stigma resulting from the fall of the corolla.

Schulz observed gynomonoecism, rarely gynodioecism.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 3 Muscids, a Syrphid, 3 humble-bees, a true wasp, and a Lepidopterid. Knuth (on garden plants), 2 po-cltg. humble-bees (Bombus agrorum *F.* ☿, and B. terrester *L.* ☿) and 3 po-dvg. hover-flies—1. Eristalis arbustorum *L.*; 2. Syritta pipiens *L.*; 3. Syrphus balteatus *Deg.*

2046. V. Thapsus L. (Sprengel, 'Entd. Geh.,' p. 121; Herm. Müller, p. 430; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 340–1; Kirchner, 'Flora v. Stuttgart,' p. 576.)—The flowers of this species are only half as large as those of V. thapsiforme, and of a brighter yellow. Darwin's experiments show that automatic self-pollination is completely effective.

Visitors.—Herm. Müller gives the following list.—

A. Diptera. *Syrphidae*: all po-dvg.: 1. Ascia podagrica *F.*; 2. Helophilus floreus *L.*; 3. Syritta pipiens *L.* **B. Hymenoptera.** (*a*) *Apidae*: 4. Andrena parvula *K.* ♂, apparently skg.; 5. Apis mellifica *L.* ☿, po-cltg.; 6. Bombus hortorum *L.* ☿, do.; 7. B. scrimshiranus *K.* ♀, do.; 8. Halictus cylindricus *F.* ♂, apparently skg.; 9. H. smeathmanellus *K.* ♀, po-cltg. (*b*) *Vespidae*: 10. Polistes gallica *L.* ♀, apparently skg. (Thuringia).

The following were recorded by the observers, and for the localities stated.—

Knuth, po-cltg. humble-bees (Bombus agrorum *F.*), and po-dvg. hover-flies, (Syritta pipiens *L.*, and Syrphus ribesii *L.*). von Fricken (Westphalia and East Prussia), 2 Curculionid beetles—Cionus verbasci *F.*, and C. thapsus *F.* Redtenbacher (Vienna), the Curculionid Cionus blattariae *F.* Heinsius (Holland), the po-cltg. humble-bee Bombus terrester *L.* ☿, and the po-dvg. hover-fly Syritta pipiens *L.* (Bot. Jaarb. Dodonaea, Ghent, iv, 1892, pp. 57–9).

2047. V. phlomoides L.—As long ago as the forties it was noticed by Gärtner that the stamens of this species degenerate (and also those of V. nigrum *L.*, V. Blattaria *L.*, V. blattarioides *? auct.*, V. phoeniceum *L.*, and V. speciosum *Schrad.*). Schulz describes the species as gynomonoecious, rarely gynodioecious; while Comes says it is self-fertile. (*Cf.* also the remarks of Maury under V. thapsiforme.)

2048. N. Lychnitis L. (white-flowered type). (Herm. Müller, 'Fertilisation,' p. 430, 'Weit. Beob.,' III, pp. 26–8; Kirchner, 'Flora v. Stuttgart,' p. 577.)—The flowers of this species are homogamous and devoid of nectar. The lowest corolla-lobe is the longest, and the two upper ones the shortest, but in spite of this the

former does not serve as an alighting-platform, for after the flower opens it becomes reflexed. The stiff filaments, which project straight out of the flower, perform this function, especially the two somewhat longer lower ones, placed below its centre. The filaments are clothed with clavate hairs. The style runs out between the two lower stamens at the same or a lower level, and since it projects beyond them the stigma must be first touched by insect visitors, and cross-pollination ensured. Automatic self-pollination becomes possible when the flowers fade, for then the stamens bend upwards and backwards and the style more strongly downwards, while the corolla curves somewhat to the front. (*Cf.* also the remarks of Maury under V. thapsiforme.)

Visitors.—Loew saw the Tenthredinid Allantus scrophulariae *L.* in the Berlin Botanic Garden, and Herm. Müller gives the following list for Thuringia.—

A. Coleoptera. (*a*) *Curculionidae*: 1. Cionus hortulanus *Marsh.*, sometimes inside the flowers; 2. Gymnetron tetrum *F.*, do. (*b*) *Telephoridae*: 3. Danacea pallipes *F.*, freq. in the flowers, po-dvg. (?). **B. Diptera.** *Muscidae*: 4. Anthomyia sp., po-dvg. **C. Hemiptera.** 5. Anthocoris sp. **D. Hymenoptera.** *Apidae*: 6. Halictus leucopus *K.* ♀; 7. H. minutissimus *K.* ♀, po-cltg.; 8. H. nitidus *Schenck* ♀, do.

2049. V. nigrum L. (Sprengel, 'Entd. Geh.,' p. 122; Herm. Müller, 'Fertilisation,' pp. 429–30, 'Weit. Beob.,' III, p. 26; Kirchner, 'Flora v. Stuttgart,' pp. 576–7; Warnstorf, Verh. bot. Ver., Berlin, xxxvii, and xxxviii, 1896.)—The yellow flowers of this species are aggregated into elongated inflorescences, and their conspicuousness is still further enhanced by violet hairs on the filaments, and the orange-red anthers. The centre of the base of the corolla is marked with five chestnut-brown patches, alternating with the bases of the filaments, and Sprengel regarded these as nectar-guides, although he was unable to find any nectar. The observations of Hermann Müller confirm this view, for he found a small moth (Ephestia clutella *Hbn.*) sucking at the place thus indicated. In many flowers he also noticed minute droplets of nectar on the smooth shining inner side of the short corolla-tube.

Except that they are of smaller size, the homogamous, almost vertical flowers agree essentially as to their mechanism with those of V. thapsiforme. The five stamens project almost horizontally, for they diverge but little, and are only slightly bent upwards. They are of unequal length: the uppermost one being the shortest, and the two lower ones the longest. The anthers dehisce extrorsely and cover themselves all over with pollen. The style is a little shorter than the lowest stamens, but is usually somewhat bent downwards, so that an insect alighting on the lowest petal and turning towards the anthers will generally touch the stigma first. In spite of homogamy, cross-pollination by insect-visits is thus favoured. But should these fail, automatic self-pollination can easily take place, for the stigma is often situated in the line of fall of the pollen. Gärtner and Darwin, however, state that it is entirely without effect.

Warnstorf describes the pollen-grains as orange-red in colour, biscuit-shaped, longitudinally furrowed, closely beset with delicate papillae, 19–20 μ broad and 37·5 μ long.

Visitors.—Herm. Müller gives the following list.—

A. Coleoptera. *Nitidulidae*: 1. Meligethes freq. **B. Diptera.** (*a*) *Bombyliidae*: 2. Systoechus sulphureus *Mik.*, skg. (*b*) *Syrphidae*: 3. Eristalis arbustorum *L.*, alternately po-dvg. and busy about the filament-hairs with its proboscis-lobes; 4. Syritta pipiens *L.*, do.; 5. Syrphus balteatus *Deg.*, do. (*cf.* Vol. I, p. 179). **C. Hymenoptera.** *Apidae*: 6. Andrena pilipes *F.* ♀, po-cltg.; 7. Bombus agrorum *F.* ☿, skg.; 8. B. terrester *L.* ♀, skg. and po-cltg.; 9. Halictus sexnotatus *K.* ♀, skg.; 10. Prosopis communis *Nyl.* ♀, po-dvg.; 11. P. signata *Pz.* ♀, do. **D. Lepidoptera.** *Microlepidoptera*: 12. Ephestia elutella *Hbn.*, skg. **E. Neuroptera.** 13. Panorpa communis *L.*, lkg. various parts of the flower. **F. Thysanoptera.** 14. Thrips, freq.

The following were recorded by the observers, and for the localities stated.—

Warnstorf, small po-dvg. beetles. Alfken (Bremen), 4 bees—1. Andrena gwynana *K.* ♀, 2nd gen.; 2. Coelioxys rufescens *Lep.* ♀, skg.; 3. Eriades truncorum *L.* ♀; 4. Halictus quadrinotatulus *Schenck* ♀, po-cltg. and skg. MacLeod (Pyrenees), 3 humble-bees and a hover-fly (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 322).

2050. V. phoeniceum L. (Kölreuter, '2. Fortsetzung,' pp. 10–11, '3. Fortsetzung,' p. 41; Sprengel, 'Entd. Geh.,' p. 122; Darwin, 'Cross- and Self-Fertilisation,' pp. 330, 341, 364; Herm. Müller, 'Fertilisation,' p. 430; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 177.)—The flowers of this species possess the same mechanism as those of V. nigrum, but Sprengel and Hermann Müller describe them as entirely devoid of nectar.

Kerner, however, says that nectar is secreted by the large lower lobe of the corolla, in the form of minute droplets scattered over its central part. One of these is exuded from every stoma, so that when the flower opens it looks as if this lobe were sprinkled with dew.

It was long ago observed by Kölreuter that the flowers are at times completely infertile with their own pollen. Self-sterility was confirmed by the investigations of Darwin, while Gärtner and Focke state that this is common. Gärtner observed reduction of the stamens (*cf.* V. phlomoides), and suggests that the occasional infertility noticed by Kölreuter may be explained if we suppose with Loew that the plants he examined were partly female gynodioecious and partly gynomonoecious.

Visitors.—Herm. Müller observed the following.—

A hover-fly (Rhingia rostrata *L.*, freq., po-dvg. and lkg. the hairs on the filaments) and 5 bees—1. Apis mellifica *L.* ☿, po-cltg.; 2. Bombus agrorum *F.* ☿, do.; 3. Andrena dorsata *K.* ♀, do.; 4. A. fulva *Schr.* ♀, vainly searching for nectar; 5. Halictus sexnotatus *K.* ♀, po-cltg.

2051. V. Blattaria L. (Sprengel, 'Entd. Geh.,' p. 121; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 177, 367; Kirchner, 'Flora v. Stuttgart,' p. 578.)—Kerner says that nectar is secreted in this species in the same way as in V. phoeniceum, but Kerner describes the homogamous flowers as nectarless. As the style projects beyond the anthers, cross-pollination by insect-visits is favoured. Towards the end of anthesis, however, automatic self-pollination takes place in the following way, according to Kerner: 'The two longer filaments cross themselves over the mouth of the corolla-tube in somewhat the same attitude as a pair of folded arms. This brings their two anthers, which are still full of the orange-coloured

pollen, behind the stigma. The corolla now becomes detached from the receptacle and falls forward, but remains for a short time suspended to the long style, where it undergoes slight torsion. Finally, it drops with a gyratory motion, and as it does so the stigma must inevitably be brushed by one or other of the anthers lying in front of the mouth of the flower.' (*Cf.* also V. phlomoides.)

Visitors.—Redtenbacher observed the Curculionid beetle Cionus blattariae *F.* at Vienna.

641. Calceolaria L.

Correns (Jahrb. wiss. Bot., Berlin, xxii, 1891) describes the nectaries as beset with long-stalked glandular hairs, producing a characteristic secretion, and in some species with chloroplasts (more rarely chromoplasts) in their stalk-cells. Correns thinks that the latter make the nectaries more conspicuous and also by means of carbon assimilation provide the necessary materials for building up the secretion. The stamens somewhat resemble those of Salvia officinalis, but with much simpler hinges, and devoid of specific mechanical cells.

2052. C. hybrida (?). — Correns (op. cit.) says that in this species the connective is immovably united with the filaments. The style projects obliquely downward between the paired anthers, and the vaulted upper lip is drawn over it as a protection. The lower lip is not in contact with the upper one, so that without moving it to any extent an insect visitor will first touch the stigma and then the anthers, thus effecting cross-pollination.

2053. C. scabiosaefolia Sims.—Correns states that the flower mechanism of this species is the same as that of C. pinnata (*vide infra*). The upper and lower lips, as seen from below, are completely apposed.

2054. C. Pavonii Benth. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 380.)—The protogynous flowers of this South American species are at first almost horizontal. The receptive stigma lies on the excavated lower lip, of which the concave middle lobe secretes nectar. The upper side of it is used by short-tongued Hymenoptera as an alighting-platform, and it sinks down as soon as they settle, thus not only widely opening the throat of the corolla, but also displaying the nectar-secreting lobe, which was previously concealed. This enables the dorsal surface of the visitor to brush against the stigma, effecting cross-pollination if an older flower had previously been visited. For in the latter dehiscence has taken place, and the connectives are so articulated with the filaments that when an insect strikes against the anthers they are swung round and the mealy pollen falls upon its back. This effect is ensured by elongation of the connectives, so that the upper anther-lobes come to lie on the uppermost convexity of the lower lip. Should insect-visits fail, part of the pollen falls upon this convexity, and, as the peduncle curves down in late anthesis, slides down the lower lip, now sloping sharply downwards, to the still receptive stigma.

2055. C. pinnata L. (Hildebrand, Bot. Ztg., Leipzig, xxv, 1867, p. 284; Correns, Jahrb. wiss. Bot., Berlin, xxii, 1891, pp. 241–52.)—Hildebrand and Correns state that in the flowers of this Peruvian species a pair of anthers are modified into two-armed levers, as in Salvia. One arm with its sterile anther-lobe lies in

the opening of the flower, and an insect visitor presses against it in such a way that the upper arm with the fertile anther-lobe comes out of the upper parts of the flower that enclose it and strews pollen upon the visitor. Should insect-visits fail, automatic self-pollination is brought about by fall of the corolla.

642. Schizanthus Ruiz et Pav.

Here, according to Hildebrand (Bot. Ztg., Leipzig, xxiv, 1866, p. 76), there are two stamens which spring out of the lower lip during insect-visits, and dust the visitors with pollen. The style subsequently elongates, so that visitors touch the stigma before the pollen and therefore effect crossing.

Juel (Vet.-Ak. Öfvers., Stockholm, li, 1894, pp. 67–72) describes the stamens as fixed by a viscid secretion to the lower lip before insect-visits have taken place, and says that their tension is due entirely to turgidity, there being no specific mechanical elements in the filaments.

643. Browallia L.

2056. B. demissa L. (=B. elata *L.*). (Delpino, 'Ult. oss.,' pp. 140–3; Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870, pp. 654–5.)—Delpino and Hildebrand describe the entrance of the flower as closed in this species by the broadened filaments of the two upper stamens, leaving only two narrow nectar-passages. The proboscis of an insect touches anthers and stigma when introduced into one of these. During the first stage of anthesis it will take up viscid matter from the stigma, and pollinate this during the second stage.

644. Salpiglossis Ruiz et Pav.

2057. S. sinuata Ruiz et Pav.—De Bonis describes this species as cleistogamous.

2058. S. variabilis Hort. (=S. sinuata *Ruiz et Pav.*, according to the *Index Kewensis*). (E. Hackel, Bot. Centralbl., Cassel, lx, 1894, p. 258.)—Hackel states that this species produces cleistogamous flowers if cultivated in poor clay soil.

645. Celsia L.

2059. C. coromandelina Vahl.—Comes describes this species as self-fertile.

646. Scrophularia Tourn.

Protogynous wasp flowers, almost without exception. Nectar is secreted at the base of the rounded widely open corolla by an annular swelling, described by Kerner as divided into two symmetrically disposed front and back lobes, the latter being more strongly developed. The secretion is in large drops. Kuhn says there are cleistogamous flowers.

2060. S. nodosa L. (Sprengel, 'Entd. Geh.,' pp. 322–4; Herm. Müller, 'Fertilisation,' pp. 434–6, 'Weit. Beob.,' III, p. 30, 'Alpenblumen,' p. 267, Kirchner, 'Flora v. Stuttgart,' pp. 578–9; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 341–2; Knuth, 'Blütenbesucher,' I, 'Bloemenbiol. Bijdragen.')—In

this species the corolla is of a pale green colour, but the inner surface of the upper lip is brown and serves as a nectar-guide. The flower is so placed that the entrance of rain-drops is prevented. It is about 5 mm. in diameter. Insect visitors, particularly wasps, touch the stigma from below during the first stage of anthesis, and the anthers during the second. The posterior fifth stamen has become unnecessary, and is modified into a small black leaflet on the upper wall of the corolla. Visitors are thus enabled to force their way into the flowers exactly in the middle line. They hold on to the outside of the corolla with all six legs, and push their heads into the entrance of the flower, pollinating those in the first stage, and dusting themselves with pollen in those in the second stage. It follows that when a number of flowers are visited in succession crossing will always take place.

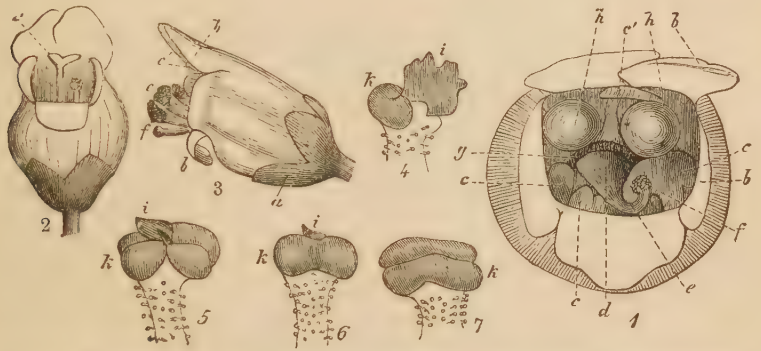


FIG. 286. *Scrophularia nodosa*, *L.* (after Herm. Müller). (1) Flower in the first (female) stage, seen directly from the front (× 7). (2) Do., from below (× 3½). (3) Older flower, pollinating itself, seen from the side. (4–7) Stages in the reversion of the fifth stamen to the original leaf-like form (read from 7 to 4) (× 12). *a*, calyx-lobes; *b*, corolla-lobes; *c*, stamens; *c'*, modified fifth stamen; *d*, ovary; *e*, style; *f*, stigma; *g*, nectary; *h*, drops of nectar; *i*, black leaf-like part of fifth stamen; *k*, anthers.

The first (female) stage of anthesis lasts for two days. The anthers are at this time unripe, and situated in the base of the flower on the bent filaments, while the style protrudes to some extent from the corolla and its receptive stigma is directed somewhat upwards. When the second (male) stage of anthesis begins, the filaments straighten and the pollinated stigma withers and bends down over the lower lip, its place being taken by the dehiscing anthers. Visitors (wasps), as Sprengel long ago noticed, are in the habit of first sucking the upper (younger) flowers of an inflorescence, working their way down to the lower (older) flowers, from which it follows that the regular crossing of distinct stocks is secured.

Should insect-visits fail the unpollinated stigma remains receptive and retains its original position, so that it gets dusted with pollen from the dehiscing anthers above it, and completely effective self-pollination is thus automatically effected.

Warnstorf describes the pollen-grains as whitish in colour, ellipsoidal, thickly tuberculated, about 37 μ long and 18–21 μ broad.

VISITORS.—Not only in Europe but also in North America wasps are the chief visitors. It would appear, however, that such visits are not equally numerous in all localities and at different seasons. In East Holstein, for example, I found the flowers to be very zealously visited by wasps during the early part of their flowering

season, while later on the honey-bee and humble-bees were almost the only visitors. Charles Robertson made a similar observation in Illinois, but he also finds that at the end of August and beginning of September, when the number of flowers is limited, wasps once more become the dominant visitors. On this he remarks, 'This seems to be significant, for when any flower becomes reduced in numbers, its proper visitors are apt to be the last to leave it.' (Trans. Acad. Sci. St. Louis (Mo.), v, 1891, p. 587.)

This recrudescence of activity on the part of wasp visitors does not usually take place in North Germany, since the flowering period is generally at an end before August. But in 1896, on the 14th of that month, after repeated heavy rains, I noticed a number of fresh blossoms, which were being visited by numerous wasps (Vespa vulgaris *L.*), that took no notice of other flowers close by. The nest of these insects was near the place.

It may further be remarked that the yellow anthers and brownish upper lip present a noteworthy agreement with the colour of the wasps which visit the flowers.

Herm. Müller (H. M.) and Buddeberg (Budd.) give the following list.—

Hymenoptera. (*a*) *Apidae*: 1. Bombus agrorum *F.* ☿ and ♀, skg. (H. M.); 2. B. pratorum *L.* ☿, numerous, skg. (H. M., Fichtelgebirge); 3. Halictus cylindricus *F.* ♀, skg. (Budd.); 4. H. flavipes *F.* ♂, do. (H. M.); 5. H. sexnotatus *K.* ♀, in large numbers, skg. and po-cltg. (H. M., Budd.); 6. H. zonulus *Sm.* ♂, skg. (H. M.). (*b*) *Vespidae*: 7. Hoplopus levipes *Shuck.* ♀, flying about the plants in large numbers, settling on the flowers and skg. (Budd.); 8. Vespa germanica *F.*, very common, skg. (H. M., Budd.); 9. V. holsatica *F.*, do. (H. M.); 10. V. media *Deg.*, do. (H. M.); 11. V. rufa *L.* do. (H. M.); 12. V. sylvestris *Scop.* ☿, numerous, skg. (H. M., Bavarian Oberpfalz); 13. V. vulgaris *L.*, very common, skg. (H. M.).

The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), the humble-bee Bombus senilis *O.* Loew (Berlin Botanic Garden).—**Hymenoptera.** (*a*) *Apidae*: 1. Apis mellifica *L.* ☿, steadily skg. and po-cltg.; 2. Halictus nitidiusculus *K.* ♀, po-cltg. (*b*) *Tenthredinidae*: 3. Allantus scrophulariae *L.* (*c*) *Vespidae*: 4. Vespa germanica *F.* ☿, skg. Knuth (Schleswig-Holstein), the honey-bee, skg., 4 skg. humble-bees (1. Bombus agrorum *F.* ☿; 2. B. hortorum *L.* ☿; 3. B. lapidarius *L.* ☿; 4. B. terrester *L.* ☿), 2 wasps (Vespa vulgaris *L.*, and V. germanica *F.*), and the po-dvg. hover-fly Syritta pipiens *L.* von Fricken in Westphalia (W.) and East Prussia (E. P.), the Curculionid beetles Cionus blattariae *F.* (E. P.) and C. scrophulariae *L.* (W., E. P.). Alfken (Bremen), 2 humble-bees, skg.—Bombus hortorum *L.* ☿, and B. lapidarius *L.* ☿. Heinsius (Holland), wasps and the humble-bee Bombus agrorum *F.* ☿ (Bot. Jaarb. Dodonaea, Ghent, iv, 1892, p. 76). MacLeod (Flanders), 3 humble-bees, one other bee (Halictus sp.), and 3 true wasps (op. cit., v, 1893, p. 342). Plateau (Flanders), the wasp Vespa holsatica *F.*, and the honey-bee. Scott-Elliott (Dumfriesshire), 2 humble-bees, a true wasp, and a saw-fly. Saunders (England), the bee Halictus sexnotatus *K.*, rare.

2061. S. vernalis L. (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The flower mechanism of this species agrees essentially with that of S. nodosa, but Warnstorf distinguishes between three stages of anthesis, and gives the following account.—In the second stage which succeeds the first (female) one, the two long stamens extend to the stigma or somewhat beyond it, and as their anthers come to lie below it and dehisce on their under-surfaces autogamy is rendered very difficult. In the third stage the style bends up and the short stamens stretch forward, their anthers being in front of the stigma. The plant

exhales an agreeable balm-like odour, and is eagerly visited by humble-bees, which cling to the flowers from below. The pollen-grains are yellowish in colour, ellipsoidal, tuberculate, about 43 μ long and 25–31 μ broad.

Visitors.—Loew observed 2 bees (Apis mellifica *L.* ☿, steadily skg. and po-cltg.; and Halictus nitidiusculus *K.* ♀, po-cltg.) in the Berlin Botanic Garden.

2062. S. aquatica L. (Herm. Müller, 'Weit. Beob.,' III, p. 30; Knuth, 'Bloemenbiol. Bijdragen.')—The flower mechanism of this species agrees with that of S. nodosa, but the corolla is rather more inflated and the style is more strongly bent downwards during the second stage of anthesis.

Visitors.—These are again predominatingly wasps (with the exception of Vespa crabro *L.*). The following were recorded by the observers, and for the localities stated.—

Buddeberg (Nassau), the bee Halictus cylindricus *F.* ♂. Knuth (East Holstein), the honey-bee, skg. Plateau (Belgium), the honey-bee, 2 wasps (Vespa sylvestris *Scop.*, and Odynerus parietum *Pz.*), and hover-flies (Helophilus sp., Syrphus sp., and Rhingia campestris *Mg.*). Rössler (Wiesbaden), 2 moths (Timandra amata *L.*, and Gnophos furvata *F.*). Redtenbacher (Vienna), the Curculionid beetle Cionus hortulanus *Marsh.*

2063. S. alata Gilib. (=S. Ehrharti *Stevens*). (Kirchner, 'Flora v. Stuttgart,' p. 579; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—In this species the corolla is of a dirty-green colour, brown on the upper-side, and it is more inflated than in S. nodosa. The flower mechanism agrees otherwise with that of the latter.

Warnstorf says that occasionally some or all of the stamens are reduced. He describes the pollen-grains as yellow in colour, ellipsoidal, closely tuberculate, up to 44 μ long and 25 μ broad.

Visitors.—Loew observed a bee (Apis mellifica *L.* ☿, skg.) and a wasp (Vespa sylvestris *Scop.*, skg.) in the Berlin Botanic Garden.

2064. S. lucida L.—This species is native to the Greek Islands. Medicus describes it as possessing a sensitive stigma.

2065. S. Hoppii Koch. (Schulz, 'Beiträge,' II, pp. 115–16.)—The flower mechanism of this species essentially agrees with that of S. nodosa. Automatic self-pollination, however, is rendered impossible or very difficult, for before the inner stamens extend themselves, or at any rate before their anthers dehisce, the style alters its more or less horizontal position and bends vertically downwards, and often a little backwards as well, thus bringing the stigma under the corolla. After the pollen has been shed it often very nearly resumes its original position.

Visitors.—Schulz observed wasps, also occasional ichneumonids and flies, at Predazzo and San Martino.

2066. S. canina L. (MacLeod, 'Pyreneënbl.,' pp. 40–1.)—The dark-violet blossoms of this species look like bee flowers, but the opening of the corolla is wide and its tube shallow.

Visitors.—These are never long-tongued bees, but Syrphids and short-tongued bees are numerous. The latter usually creep right into the flowers.

The following were recorded by the observers, and for the localities stated.—

MacLeod (Pyrenees), 3 bees (Halictus sp.), an Ichneumonid, and 5 hover-flies. Schletterer (Pola), the bee Halictus variipes *Mor.*

2067. S. lateriflora Trautv. (Urban, Ber. D. bot. Ges., Berlin, iii, 1885; Loew, 'Blütenbiol. Beiträge,' I, pp. 24–7.)—This species is native to the Caucasus. It bears as markedly protogynous wasp flowers as S. nodosa, and their mechanism is similar.

2068. S. peregrina L. (Comes, 'Ult. stud.')—Comes describes this species as self-fertile.

2069. S. Scopolii Hoppe.—

Visitors.—Plateau noticed the honey-bee.

2070. S. orientalis L.—

Visitors.—Plateau (Ghent) observed the honey-bee, a saw-fly (Allantus tricinctus *Chr.*), and a wasp (Odynerus quadratus *Pz.*).

2071. S. alpestris J. Gray. (MacLeod, 'Pyreneënbl.,' p. 41.)—The flowers of this species are yellow and violet in colour.

Visitors.—MacLeod (Pyrenees) observed more especially a wasp (Vespa sylvestris *Scop.*); also 2 humble-bees.

647. Antirrhinum Tourn.

Homogamous bee or humble-bee flowers with valvular mechanism. Their entrance is completely closed by the upper and lower lips of the corolla. The latter possesses two swellings serving as alighting-platforms, and fitting accurately into two depressions of the upper lip. The anthers are completely enclosed in the corolla, close against the upper lip, and their pollen is dehisced in two rounded masses, which both adhere to the back of a humble-bee forcing its way into the flower. Nectar is secreted by the base of the ovary. Medicus describes the stigma as sensitive.

2072. A. majus L. (Sprengel, 'Entd. Geh.,' pp. 320–1; Herm. Müller, 'Fertilisation,' pp. 433–4, 'Weit. Beob.,' III, pp. 29–30; Schulz, 'Beiträge'; Kirchner, 'Flora v. Stuttgart,' p. 580; Knuth, 'Bloemenbiol. Bijdragen.')—The flowers of this species are bright-purple or rarely white in colour, with a yellow palate. As long ago observed by Sprengel nectar is secreted by the front part of the base of the ovary, which is smooth, green, fleshy, and usually rather swollen anteriorly. Elsewhere the ovary is of a whitish colour, and clothed with short fine hairs. The nectar remains clinging to the gland, resting below upon the forwardly directed bases of the anterior filaments, above the spur, into which, as Sprengel says, it does not flow of its own accord. The spur is short and broad, and humble-bees probing for nectar are obliged to insert their proboscis into it from below. Access from above and in front is blocked by stiff capitate hairs which cover the anterior filaments where they bend up.

Visitors.—These are exclusively long-tongued bees, especially humble-bees, which can easily force open the flowers and creep entirely into them, backing out again with the pollen-masses adhering to their backs. During this procedure

they may effect either cross- or self-pollination. Herm. Müller saw smaller bees (Halictus sp.) flying from flower to flower, but immediately turning away from those still closed, till they came to old ones which gaped a little in fading. Into these they made their way, but such visits were of no use to the plant. Schulz says that the humble-bee Bombus terrester *L.* sometimes perforates the spur and steals the nectar, though he also often saw it sucking legitimately. Automatic self-pollination is possible, but less effective than cross-pollination. Darwin says that this species is sometimes sterile, sometimes self-fertile: that the red variety is twice as fertile when insect-visits take place as when they are excluded: that self-fertilization is more common in the white variety than the red: and that the peloric form is completely fertile when artificially self-pollinated.

Herm. Müller records the following 8 bees for Westphalia and Thuringia.—

1. Anthidium manicatum *L.* ♀; 2. Bombus agrorum *F.*; 3. B. hortorum *L.*; 4. B. lapidarius *L.*; 5. B. sylvarum *L.*; 6. B. terrester *L.*; 7. Megachile fasciata *Sm.* ♂; 8. Osmia *L.* ♀.

Müller makes the following remarks about these bee-visitors: 'The females and workers [of the 5 humble-bee species], and in late summer the males also, creep bodily into the flower, and creep out backwards dusted on their backs with pollen. From time to time they brush off the adhering pollen from their thorax with the tarsal brushes of the fore or midlegs, and from the abdomen with the tarsal brushes of the hindlegs. Not only the females and workers, but the males also, perform this action, which seems, therefore, to be done more for cleanliness than to collect the pollen, though the females and workers naturally make use of it, placing it in the pollen-baskets on their hindlegs. I have also seen *Anthidium manicatum* L. ♀, *Megachile fasciata* Sm. ♂, and *Osmia rufa* L. ♀, creep into the flower and emerge with their backs covered over with pollen. Smaller bees only exceptionally creep into still fresh flowers, and are useless to the plant: I have only once seen *Megachile centuncularis* L. ♀ succeed in entering; on the other hand I have repeatedly seen small species of *Halictus* (*H. zonulus* Sm. ♀, *H. morio* F. ♀, *H. Smeathmanellus* K. ♀) flying from flower to flower until they reached an old flower, which in withering had opened slightly and permitted them to enter. This showed clearly how far the fast closure of the mouth is useful to the plant; if the small bees could enter from the first, they would use up much of the honey, and the flowers would be less diligently visited by the humble-bees.'

The following were recorded by the observers, and for the localities stated.—

Knuth (Schleswig-Holstein), 4 humble-bees all skg. legitimately—1. Bombus agrorum *F.* ♀ and ☿; 2. B. hortorum *L.* ♀, ☿ and ♂; 3. B. lapidarius *L.* ☿ and ♀; 4. B. terrester *L.* ♀, ☿ and ♂. Loew (Berlin Botanic Garden), the humble-bee Bombus agrorum *F.* ♀, skg. Douglas, 5 bees (Ent. Mag., London, xxiii, 1886)—1. Apis mellifica *L.* ☿; 2. Bombus derhamellus *K.* ♀ and ☿; 3. B. terrester *L.*, var. lucorum *L.* ☿; 4. B. terrester *L.*, var. audax *Harr.* (=B. virginalis *Fourcr.*) ♀ and ☿; 5. Megachile centuncularis *L.* Neumann recorded Nos. 2, 3, and 5 of these as far back as 1850. Schletterer (Tyrol), the humble-bee Bombus lapidarius *L.* P. Magnus (Natw. Rdsch., Braunschweig, vi, 1891, p. 20) noticed that humble-bees were able to suck for a longer time when they did so legitimately than when they perforated the flowers, and this may be regarded as an adaptation to the visits of these insects.

2073. A. sempervirens Lapeyr. (MacLeod, 'Pyreneënbl.,' p. 41.)—The flowers of this species are white in colour, and the swellings on the lower lip pale yellow. Only humble-bees are strong enough to force them open. A pale-violet patch on the upper lip serves as a nectar-guide. The spur is divided by a partition into lower and upper parts, the latter only containing the nectar secreted by the ovary.

Visitors.—MacLeod observed the humble-bee Bombus hortorum *L.* in the Pyrenees.

2074. A. Orontium L. (Knuth, Bot. Centralbl., Cassel, lxxi, 1897.)—This species bears homogamous bee flowers. They are of medium size, red, rarely white in colour, arranged in scanty racemes, and therefore not very conspicuous. The rose-coloured (rarely whitish) upper lip is 8–10 mm. broad, and marked with dark-red streaks that converge to the opening of the flower closed by the palate. The lower lip is similarly coloured, but the streaks upon it are feebler, and its summit is marked with a pale-yellow nectar-guide, from either side of

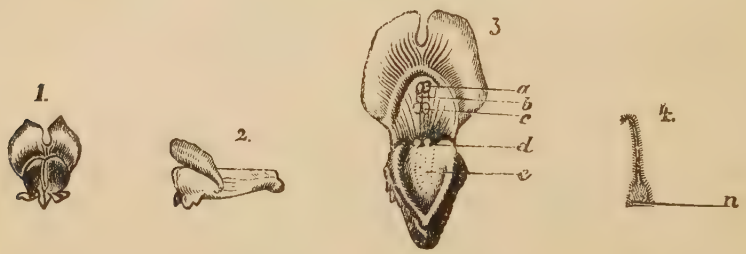


Fig. 287. *Antirrhinum Orontium*, *L.* (from nature). (1) Flower, seen from the front. (2) Corolla, seen from the side. (Natural size.) (3) Flower with the lower lip pressed down, seen from the front (× 2). *a*, *b*, anthers of the longer and shorter stamens; *c*, stigma; *d*, the two rows of bristles which guide the proboscis of a bee into the base of the flower; *e*, hairs lining the lower lip which receive pollen. (4) Pistil seen from the side (× 2); *n*, nectary.

which (in rose-coloured flowers) a white zone runs along the lower edge of the closed entrance. If the flower is opened by pulling down the lower lip it will be seen that the red streaks of both lips are continued into the corolla-tube, which is only 6–7 mm. long, and produced below into a sort of spur. The upper lip interlocks by means of a keel-like projection with a corresponding depression of the lower lip, thus closing the flower more firmly. The sides of the lower lip are almost vertical, so that rain-drops falling upon the flower are not able to injure it.

The four anthers are situated inside the upper lip, immediately below the keel-like projection. Those of the two longer stamens project beyond the stigma, while those of the two shorter ones are at a lower level. The stigma, borne upon a style bent at the end somewhat like a hook, therefore occupies the space between the two pairs of anthers.

That part of the inner surface of the lower lip which touches the anthers in the closed flower is densely clothed with numerous small yellow hairs. These are to some extent felted together, and the pollen is shed upon them. They are continued into two rows of stiff, yellow, erect, capitate bristles, which run down

into the base of the flower, and guide the proboscis of a bee probing for nectar. Nectar is scantily secreted by a swelling at the base of the ovary, which is strongly developed at the sides and towards the spur in which it is concealed.

Only bees are able to open the flowers and regularly effect pollination. The head of such a visitor is introduced into the entrance of the flower (4 mm. wide), and while probing for nectar its extended proboscis touches the somewhat projecting stigma, after which its upper side (or the front of the head) is first dusted with pollen by the anthers of the longer stamens and then by those of the shorter ones. The second flower visited will therefore be cross-pollinated. Should insect-visits fail automatic self-pollination is brought about by the pollen clinging to the hairy lining of the lower lip.

Visitors.—Knuth observed the following.—

On August 8, 1897 (in fields near Kiel), Apis mellifica *L.* ☿, flying persistently from flower to flower, and therefore effecting crossing. The proboscis of this bee (about 6 mm. long) corresponds to the depth at which nectar is concealed. On August 12, 1897, 2 humble-bees (Bombus terrester *L.* ☿, and B. lapidarius *L.* ♂) were also observed, behaving like the honey-bee. Their proboscides, respectively 7–8 mm. and 8–10 mm. in length, can easily secure all the nectar. Large numbers of Thrips were also noticed, but they never effected crossing.

648. **Linaria** Tourn.

Flowers personate, usually homogamous, and adapted to the visits of bees or humble-bees. Nectar secreted by the fleshy base of the ovary, and stored in a spur. Two projections on the palate serve as alighting platforms.

2075. L. vulgaris Mill. (=Antirrhinum Linaria *L.*). (Sprengel, 'Entd. Geh.,' pp. 317–20; Herm. Müller, 'Fertilisation,' pp. 431–2; Delpino, 'Sugli appar. d. fecondaz. nelle piante autocarp.,' p. 32; Kirchner, 'Flora v. Stuttgart,' p. 581; Knuth, 'Bloemenbiol. Bijdragen,' 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 164, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 238, 'Blütenbiol. Notizen'; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 343–5, vi, 1894; 'Bl. u. Insekt. a. d. Ins. Norderney.')—The flowers of this species are bright-yellow in colour, with an orange-yellow nectar-guide on the lower lip. Nectar is secreted by the base of the ovary, and Hermann Müller states that 'it glides in a smooth, narrow groove, bordered by short, stiff hairs, which passes from the nectary between the two anterior stamens, and thence to the tip of the spur, which it fills to a depth of 5 or 6 mm. or even more.' Sprengel, on the other hand, says that the nectar 'remains in the opening of the spur till a certain amount accumulates, and then rapidly flows down into it,' so that the tip of the spur remains full of air. Hermann Müller examined several hundred flowers, but only found two that agreed with Sprengel's description, and therefore

Fig. 288. *Linaria vulgaris, Mill.* (from nature). A flower (natural size) seen from the front after removal of the lower lip. The two pairs of stamens are seen below the somewhat arched upper lip, with the stigma in the space between their anthers.

thinks it may well be supposed that the latter was founded upon exceptional cases. Jordan says that the two anterior lobes of the nectary are more strongly developed than the two posterior ones.

The length of the spur debars short-tongued bees from sucking the nectar, while the personate character of the flowers excludes flies, Lepidoptera, and beetles. Only long-tongued bees can suck legitimately and effect crossing. They press down the lower lip and creep into the flowers, which are adapted in size to those able to suck the nectar. As the style and stamens lie against the upper lip such visitors when sucking brush the dorsal side of their bodies against the simultaneously mature anthers and stigma. Since the latter is placed between the two pairs of anthers cross- and self-pollination are effected with equal facility. Automatic self-pollination also easily takes place, but Darwin says that it is always ineffective. Warnstorf describes the pollen-grains as yellow in colour, smooth, and almost spherical when examined in water.

As I have elsewhere pointed out ('Blütenbiol. Notizen'), there is an admirable arrangement for conducting the proboscis of an insect to the nectar. When a humble-bee opens the flower by depressing the lower lip it finds an orange-coloured nectar-guide on either side of this, which is not simply, as usual, a mere colour-streak running into the nectar-containing spur. It is, in fact, a ridge composed of closely packed, almost erect orange-coloured hairs, and a smooth hairless space 1 mm. broad is left between the two guides. A bee or humble-bee cannot force its proboscis through these hairy barriers, but is obliged to thrust it along the smooth median groove, and in doing this rubs the upper side of its head, prothorax, and mesothorax against the stigma and anthers.

Visitors.—Herm. Müller observed various species of ants, freq., skg., and also records the following bees.—

1. Apis mellifica *L.* ☿, very freq.; 'To suck, it creeps almost entirely into the flower and thrusts its head into the wide entrance of the spur, which it empties down to a depth of 2–3 mm. It creeps out again with its back covered with pollen, and proceeds more frequently to flowers at the same height on neighbouring plants than to higher flowers on the same. In other cases I have seen the honey-bee bite a hole in the spur, and empty it, as Sprengel describes. Sprengel has correctly described its behaviour while collecting pollen; 'It slightly separates the lower lip of the corolla from the upper, and thrusts its head so far in as to reach the anthers and obtain their pollen.' 2. Bombus terrester *L.* ♀, skg. legitimately; 'It inserts its head, thorax, and forelegs into the flower, then thrusts its proboscis (7–9 mm.) almost to the tip of the spur, and emerges with the upper surface of its head, pro- and mesothorax thickly covered with pollen. Sometimes it sweeps off part of this pollen with the brushes on its fore- and midlegs, and places it on the hindlegs. Sprengel's idea that the large humble-bees do not enter the mouth of the flower is accordingly erroneous.' 3. B. hortorum *L.* ♀, ☿ and ♂; 'I have very frequently seen this bee empty the flowers of their honey, which it can do more quickly, owing to the length of its proboscis (17–21 mm.), than the preceding species. Even the males sometimes swept the pollen off their heads with their forelegs, and always had a number of pollen-grains on all their tarsal brushes.' 4. Megachile maritima *K.* ♂ (prob. 8–9 mm.), skg. 5. Osmia aenea *L.* ♀ (prob. 9–10 mm.), freq., skg. and po-cltg. 6. O. leucomelaena *K.* (=O. parvula *Duf.*) ♀ (prob. 2½ mm.), po-cltg. 7. Anthidium manicatum *L.* ♀ and ♂ (prob. 9–10 mm.), both skg. and ♀ po-cltg. 8. Andrena gwynana *L.* ♀ (prob. 2½ mm.), po-cltg.

Verhoeff observed the following in Norderney (n.-t. nectar-thief).—

A. Coleoptera. (*a*) *Nitidulidae*: 1. Meligethes sp. (n.-t.). (*b*) *Curculionidae*: 2. Gymnetron pilosum *Schönh.* **B. Diptera.** (*a*) *Muscidae*: 3. Calliphora erythrocephala *Mg.* (n.-t.); 4. Cynomyia mortuorum *L.* (n.-t.); 5. Lucilia latifrons *Schin.* (n.-t.). (*b*) *Syrphidae*: 6. Eristalis arbustorum *L.* (n.-t.); 7. Syritta pipiens *L.* (n.-t.); 8. Syrphus corollae *F.* (n.-t.). **C. Hymenoptera.** (*a*) *Apidae*: 9. Bombus hortorum *L.* ♂, very common, skg. legitimately; ♀, not infrequent, do.; ☿, perforating the spur and skg. (n.-t.); 10. B. lapidarius *L.* ☿ (n.-t.); 11. B. terrester *L.* ♀ and ♂, not infrequent, ☿ freq. (n.-t.). (*b*) *Formicidae*: 12. Formica fusca *L.* (Rasse fusca *Forel*), ☿ (n.-t.). (*c*) *Vespidae*: 13. Odynerus parietum *L.* (n.-t.).

Alfken gives the humble-bee Bombus hortorum *L.*, rare, skg., for Juist, and the following list for Bremen.—

Hymenoptera. (*a*) *Apidae*: 1. Bombus agrorum *F.* ♂; 2. B. hortorum *L.* ☿, ♀ and ♂, skg., and the var. nigricans *Schmiedekn.* ♀, skg.; 3. B. pomorum *Pz.* ☿; 4. B. proteus *Gerst.* ☿; 5. B. sylvarum *L.* ♀. (*b*) *Vespidae*: 6. Odynerus clavipennis *Thms.* ♀.

The following were recorded by the observers, and for the localities stated.—

Knuth (Schleswig-Holstein), 4 bees—1. Apis mellifica *L.* ☿, skg. legitimately; 2. Bombus agrorum *F.* ☿; 3. B. hortorum *L.* ♀ and ☿, perforating the flowers and stealing nectar; 4. B. terrester *L.* ♀, partly skg. legitimately, partly perforating the flowers and stealing nectar. Loew (Silesia), the humble-bee Bombus rajellus *K.* ☿, skg. ('Beiträge,' p. 28). von Fricken (Westphalia and East Prussia), 2 beetles, damaging the flowers—the Curculionid Gymnetron linariae *Pz.*, and the Nitidulid Brachypterus gravidus *Ill.* von Dalla Torre (Tyrol), the humble-bee Bombus mastrucatus *Gerst.* ☿. Schletterer (Tyrol), 2 humble-bees—Bombus alticola *Krchb.*, and B. ruderatus *F.* Scott-Elliot (Dumfriesshire), the honey-bee and 2 humble-bees ('Flora of Dumfriesshire,' p. 126). MacLeod (Flanders), the humble-bee Bombus hortorum *L.* ♂ and ☿, freq., dusted with pollen; a species of Halictus, stealing nectar; 3 hover-flies, vainly trying to suck, and po-dvg.; and a beetle (Cetonia sp.), creeping right into the flowers (Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 343–5, vi, 1894, p. 371).

2076. L. minor Desf. (Herm. Müller, 'Weit. Beob.,' III, pp. 28–9; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 345; Kirchner, 'Flora v. Stuttgart,' p. 582; Kerner, 'Nat. Hist. Pl.,' Eng. Ed., 1, II, p. 407.)—The flowers of this species are rather inconspicuous, and bright-violet in colour with a pale-yellow palate. Their mechanism essentially agrees with that of L. vulgaris, but no insect-visits have so far been observed. Automatic self-pollination, on the contrary, seems regularly to take place. When the flower opens the anthers dehisce, covering the simultaneously mature stigma with pollen. Kerner says that autogamy is brought about by elongation of the corolla, whereby the anthers are brought into contact with the stigma. Warnstorf describes the pollen-grains as white in colour, ovoid, smooth, about 25 μ long and 19 μ broad.

2077. L. littoralis Willd. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 407.)—Automatic self-pollination takes place in this Croatian species as in L. minor.

2078. L. repens Mill. (=L. striata *DC.*). (Kirchner, 'Beiträge,' p. 53; Loew, 'Blütenbiol. Floristik,' p. 292.)—The flowers of this species are of a pale bluish colour, marked with blue lines. Their mechanism agrees with that of L. vulgaris,

though they are considerably smaller. The brighter lower lip is beset with golden-yellow hairs in the middle. The spur is only 2–3 mm. long.

Visitors.—Loew (Berlin Botanic Garden) observed the hover-fly Syritta pipiens *L.*, settling, and 2 bees, both skg.—Apis mellifica *L.* ☿, and Bombus agrorum *F.* ♂.

2079. L. alpina Mill. (Herm. Müller, 'Alpenblumen,' pp. 275–7; MacLeod, 'Pyreneënbl.,' p. 47.)—This species bears humble-bee flowers which are differently coloured from those of L. vulgaris, but otherwise possess essentially the same mechanism. Their cavities are wide enough to admit the head of a humble-bee. There is the same possibility of autogamy as in L. vulgaris. In the Alps the flowers are blue-violet in colour, usually with an orange-coloured nectar-guide on the lower lip; in the Pyrenees they are darker, and the nectar-guide is generally only represented by a small yellow patch.

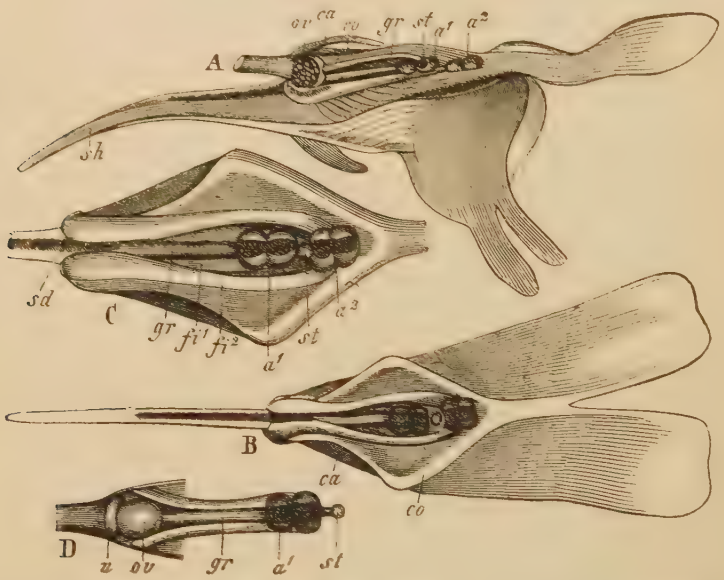


Fig. 289. *Linaria alpina*, *Mill.* (after Herm. Müller). *A*. Flower in longitudinal section. *B*. Upper part of a flower seen from below. *C*. Central part of do., further enlarged. *D*. Pistil, upper (shorter) stamens, and nectary. (*A*, *B* × 5; *C*, *D* × 7.) a^1, a^2, anthers of short and long stamens; *ca*, calyx; *co*, corolla; fi^1, fi^2, filaments of short and long stamens; *gr*, style; *n*, nectary; *ov*, ovary; *sd*, nectar-cover; *sh*, spur; *st*, stigma.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 2 humble-bees, skg. legitimately; the hawk-moth Macroglossa stellatarum *L.*, occasionally skg.; and a moth, trying to suck. MacLeod (Pyrenees), the last-named hawk-moth. Herm. Müller also observed perforations, apparently made by the humble-bee Bombus mastrucatus *Gerst.*

2080. L. supina Desf. (=pyrenaica *DC.*). (MacLeod, 'Pyreneënbl.,' pp. 321–2.)—The flowers of this species are pale yellow in colour, with an orange nectar-guide on the lower lip. Their structure is essentially the same as in L. alpina. A proboscis 15–20 mm. long is necessary to reach the nectar.

Visitors.—MacLeod observed perforations, probably made by Bombus mastrucatus *Gerst.* or B. terrester *L.*

2081. L. origanifolia DC. (MacLeod, 'Pyreneënbl.' pp. 42–6.)—This species bears bee flowers which possess (?), according to MacLeod, a special small opening through which Bombyliids can suck. The upper lip is bilobed, while the lower one consists of three lobes each divided into two. The colour of the flowers is violet, with dark veins on the upper lip. The lower lip possesses a yellow nectar-guide, and is raised into six irregular finely spinose ridges which are continued into the interior of the corolla, where, however, the middle ones become glabrous. Between the two median swellings of the palate there is an entrance leading into the central non-spinose area on the floor of the corolla. The compressed spur is 3·5 mm. long. The lower lip is limp, so that it can be opened by nectar-seeking insects without the use of much force. MacLeod considers the mechanism as adapted to Bombyliids, though he never saw any of them on the flowers.

Visitors.—MacLeod only observed Curculionid beetles as unbidden guests.

2082. L. arvensis Desf. (Herm. Müller, 'Weit. Beob.,' III, p. 29.)—The insignificant flowers of this species are purely autogamous. Hermann Müller never observed any visitors, though he often watched them in favourable weather.

2083. L. italica Trevir. (Schulz, 'Beiträge,' II.)—The flower mechanism of this species agrees with that of L. vulgaris.

Visitors.—Schulz observed very numerous bees at Bozen (including Bombus terrester *L.*) which sometimes perforated the flowers.

2084. L. spuria Mill. (Kirchner, 'Flora v. Stuttgart,' p. 583: Ascherson, Verh. bot. Ver., Berlin, xxvii, (1885) 1886, p. 21.)—In this species the upper lip of the corolla is dark purple-brown in colour, and the lower lip citron-yellow, generally without nectar-guides, though it is somewhat blotched with dark purple-brown. The nectar-containing spur is of a bright yellow colour, and 6 mm. in length. The four stamens lie, as usual, against the inside of the upper lip, the two shorter ones being straight, while the longer ones are sharply bent up at their ends, so that the tips of the anthers are directed backwards, while their morphologically under-surfaces face upwards. All four anthers adhere together, and the simultaneously mature stigma lies between them. Where the anthers are connected they bear tufts of short collecting-hairs, and they dehisce internally, i.e. towards the stigma, so that automatic self-pollination is inevitable.

Michalet and Ascherson describe thin short twisted branches which arise in the axils of the lower leaves, bury themselves in the earth, and bear subterranean cleistogamous flowers with a reduced corolla.

2085. L. Cymbalaria Mill. (Kirchner, 'Flora v. Stuttgart,' p. 582: Herm. Müller, 'Weit. Beob.,' III, p. 29.)—The flowers of this species are lilac in colour, with two orange-yellow patches on the lower lip, which is whitish inside and orange as far as the beginning of the spur. Kirchner says that their mechanism essentially agrees with that of L. vulgaris, but the spur is only 3 mm. long, and glabrous, but furrowed internally; the bases of the two long filaments, on the other hand, are beset with minute hairs.

Visitors.—Borgstette observed the following at Tecklenburg.—

A. Diptera. *Syrphidae*: 1. Helophilus hybridus *Loew*. **B. Hymenoptera.** *Apidae*: 2. Apis mellifica *L.* ☿, freq., skg.; 3. Andrena albicans *Müll.* ♀, skg.; 4. Halictus albipes *F.* ♀, do.; 5. H. cylindricus *F.* ♀, freq., skg.; 6. H. sexnotatus *K.* ♀, skg. **C. Lepidoptera.** *Rhopalocera*: 7. Pieris rapae *L.*, skg.

2086. L. genistifolia Mill.—

Visitors.—Loew observed the bee Apis mellifica *L.* ☿, steadily skg., in the Berlin Botanic Garden.

2087. L. purpurea Mill.—

Visitors.—Loew observed the honey-bee, skg., and the humble-bee Bombus agrorum *F.* ♂, do., in the Berlin Botanic Garden.

649. Phygelius E. Mey.

2088. P. capensis E. Mey. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 384.)—In this Cape species the peduncles are bent in a hook-like way, and the young just-opened flowers are inclined downwards almost at right angles. Since they are protogynous, they can only be cross-pollinated in the early days of anthesis, and the style is at first bent in such a way that the stigma is placed in the opening of the passage leading to the nectar-containing base of the flower, and must therefore be touched by insect visitors. The style then straightens itself, so that the stigma is removed from its first position, which is then occupied by the dehisced anthers. As at the same time the peduncle continues to curve the tubular corolla is brought nearer the main axis of the inflorescence. The stigma is thus brought under the shrivelling anthers, from which pollen can fall upon it. If, however, this does not take place, autogamy is ultimately ensured by the falling corolla drawing the anthers over the stigma, and transferring the last remaining pollen-grains to it.

650. Erinus L.

Homogamous Lepidopterid flowers.

2089. E. alpinus L. (Loew, 'Blütenbiol. Floristik,' p. 50.)—Loew examined the flowers of cultivated plants of this species, and describes them as reddish-violet in colour, and possessing a narrow corolla-tube, about 5 mm. long, in the base of which is stored up the nectar secreted by an annular swelling at the base of the ovary. Self-pollination, favoured by homogamy, is possible.

Visitors.—MacLeod saw 2 Lepidoptera and a fly in the Pyrenees.

651. Gratiola L.

Flowers white or reddish in colour; with concealed nectar secreted by a disk below the ovary.

2090. G. officinalis L. (Vaucher, 'Hist. phys. des pl. d'Europe,' III; Loew, 'Blütenbiol. Floristik,' pp. 289–90.)—The stigma in this species opens its two thin papillose lobes at a late stage of anthesis, and quickly closes. Linnaeus and Medicus describe it as sensitive. The ends of the two fertile stamens are hairy, and the anthers turn their dehisced sides to the stigma, which thus gets covered

with pollen, though this is prevented from actually touching it by a semitransparent membrane.

652. Mimulus L.

Homogamous bee flowers, with irritable stigma (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 280–1).

2091. M. luteus L. (=M. guttatus *DC.*). (Batalin, Bot. Ztg., Leipzig, xxviii, 1870, pp. 53–4.)—Bees probing the flowers of this species first touch the lower lobe of the stigma, which covers the anthers, and pollinate it if they have previously been dusted with pollen in another flower. The lobe is irritable and now turns up, exposing the pollen-covered anthers, by which the visitors are dusted anew. (*Cf.* Burck, Versl. Wis. Nat. Afd. K. Akad. Wet., Amsterdam, x, 1902.)

2092. M. Tilingii Regel. (Behrens, 'Beiträge zur Geschichte d. Bestäubungstheorie,' 1877–8.)—Behrens describes the flower mechanism of this species as similar to that of M. luteus.

2093. M. glutinosus Wendl., var. β (=Diplacus puniceus *Nutt.*). (Hildebrand, Bot. Ztg., Leipzig, xxv, 1867, p. 284.)—Hildebrand describes the flower mechanism of this species as similar to that of M. luteus.

653. Glossostigma Wight et Arn.

2094. G. elatinoides Benth. (Cheeseman, Trans. and Proc. N. Zeal. Inst., Wellington, v, 1872, pp. 352–7.)—Cheeseman describes the flowers of this species as possessing an irritable one-lobed stigma.

654. Rehmannia Libosch, and 655. Torenia L.

Species of these genera possess an irritable bilobed stigma.

656. Collinsia Nutt.

2095. C. bicolor Benth. (Delpino, 'Ult. oss.,' pp. 151–2; Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870, p. 658.) Delpino says that the blossoms of this species present a certain similarity to butterfly flowers. The stamens and style are on their lower, and the nectary on their upper side. Hildebrand states that when insects are excluded effective autogamy takes place.

2096. C. verna Nutt.—As the last species.

2097. C. canadensis (*? auct.*). (Breitenbach, Kosmos, Stuttgart, xiv, 1884.)—Breitenbach says that there are three kinds of flower in this species—large hermaphrodite, small female, and some with one reduced anther.

657. Vandellia L.

2098. V. pyxidaria Maxim. (=Lindernia pyxidaria *All.*). (Urban, Ber. D. bot. Ges., Berlin, ii, 1884; Loew, 'Blütenbiol. Floristik,' p. 290.)—There are three forms of flower in this species.—(1) Chasmogamous, with corolla projecting beyond the corolla for twice its length (Maximovicz); (2) cleistogamous (Lindernia pyxidaria

All.), with calyx-teeth projecting beyond the small corolla (Maximovicz); (3) intermediate, with a scarcely open corolla hardly projecting beyond the calyx-teeth (Urban). Forms (1) and (2) may be associated on the same plant. In chasmogamous flowers the filaments of the two long stamens are so bent that their anthers lie above those of the two short ones, which are only about half as long: the anthers have long appendages, and the style projects considerably beyond them. The appendages of the anthers of cleistogamous flowers from the same plant (growing at Regensburg) were, on the contrary, very short; the anterior stamens possessed straight filaments, and were a little longer than the posterior ones, of which the filaments were slightly curved; and the anthers were applied to the stigma, situated at the end of a straight style about one-third as long. In Central and South Europe both forms of flower possess free anthers; in Asia these are usually adherent, while at the same time they are arranged in pairs under the upper lip owing to the curving of the filaments. This indicates a more marked adaptation to cross-pollination.

In temperate Europe and Asia cleistogamous flowers predominate, and are rarely associated with chasmogamous ones on the same plant. In South and West Europe chasmogamous flowers occur together with the more numerous cleistogamous ones. The former only are to be found in Further India.

658. Hysanthes Benth.

2099. H. gratioloides Benth. (Urban, Ber. D. bot. Ges., Berlin, ii, 1884; Loew, 'Blütenbiol. Floristik,' pp. 290–1.)—This North American species, introduced into France, bears both chasmogamous and cleistogamous flowers. The latter possess a pale corolla considerably exceeded in length by the calyx-teeth, while the two posterior stamens bend somewhat towards each other and the middle of the flower. The anthers are thus brought to the two sides of the style and the stigma with its ill-defined lobes, to which the pollen-grains adhere and into which their pollen-tubes penetrate. The two anterior stamens are modified into staminodes, represented in the chasmogamous flowers by short narrow threads, somewhat thickened above, and corresponding to the appendages of the anthers. They spring from glandular ridges in the lower part of the corolla-tube, and are themselves beset with glands. Each is continued into a much thinner thread, given off at a variable height at a right or obtuse angle. Instead of the glandular appendages the cleistogamous flowers possess only an inconspicuous swelling or a small capitate process, behind which the true staminode appears in the form of an oblique thread.

659. Limosella L.

2100. L. aquatica L.—Kerner states that when the small flesh-coloured flowers of this species are submerged they remain closed, and fertilize themselves pseudocleistogamously.

660. Digitalis L.

Protandrous humble-bee flowers; with nectar secreted by an annular swelling at the base of the ovary.

2101. D. purpurea L. (Sprengel, 'Entd. Geh.,' p. 325; Ogle, Pop. Sci. Rev., London, ix, 1870, p. 49; Herm. Müller, 'Fertilisation,' pp. 437–8; Ludwig, Kosmos, Stuttgart, xvii, 1885, p. 107; Kirchner, 'Flora v. Stuttgart,' p. 585; Knuth, 'Blütenbiol. Beob. in Thüringen,' 'Blütenbesucher,' II, 'Blütenbiol. Beob. a. d. Ins. Rügen'; 'Bloemenbiol. Bijdragen.')—The large red flowers of this species are aggregated into very conspicuous unilateral racemes. Their form is that of an elongated, somewhat flattened cylinder, obliquely truncated, and slanting downwards: $4\frac{1}{2}$–$5\frac{1}{2}$ cm. long and 1·5–1·7 cm. broad. (*Cf.* Fig. 290.) The position and form of the corolla protect the internal parts of the flower from rain. The inner side of the corolla on its somewhat produced lower lip is provided with nectar-guides in the form of dark-purple blotches with white margins. This region is beset with hairs 5 mm. long, which serve, according to Kirchner, to prevent the smaller useless insects from getting at the nectar. It seems to me, however, that they are so loosely arranged and so limited in extent, that they are not able to prevent such insects from creeping into the flowers. My opinion is that these hairs give insect-visitors a firm grip.

Nectar is secreted by an annular swelling below the ovary, and stored in the base of the corolla-tube. The dimensions of the bell correspond to those of humble-bees, and as a matter of fact it is these insects only which seek out the nectar of the foxglove and effect pollination in doing so.

Fig. 290. *Digitalis purpurea*, *L.* (after Plateau) Flower, natural size.

The style and stamens lie against the upper side of the corolla on the way to the nectar, so that a humble-bee creeping right into the flower and probing for nectar must touch the anthers and stigma with its dorsal surface. The anthers of the two long stamens first dehisce, then those of the short ones, and finally the stigmatic lobes diverge. When the visits of humble-bees are numerous, all the pollen is removed from the anthers before the stigma is mature, so that cross-pollination is inevitable. Should there be no such visits, the anthers are covered with pollen when the stigmatic lobes diverge; hence automatic self-pollination is possible. This is apparently effective, for in continuous rainy weather almost all the flowers set fruits. Darwin, however, describes the flowers as self-sterile. Kerner says that the anthesis of an individual flower lasts for six days.

Besides protandrous hermaphrodite flowers, Ludwig also observed small-flowered female stocks, which make up about 1 % of the whole in the neighbourhood of Kleinschmalkalden. These female flowers are not only smaller than hermaphrodite ones, but also less strongly zygomorphous. Their stamens are reduced, and the anthers contain shrivelled pollen-grains. All the vegetative parts of the female stocks are also dwarfed.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth, only the humble-bee Bombus hortorum *L.* ♀, skg., on wild plants in Westphalia and Thuringia, and garden ones in Schleswig-Holstein, Mecklenburg, and Pomerania (island of Rügen). Sprengel (besides Thrips), a humble-bee, delineated on his title-page, and probably Bombus terrester *L.* Herm. Müller, 3 humble-bees (1. Bombus agrorum *F.* ♀; 2. B. hortorum *L.* ♀; 3. B. terrester *L.* ♀); also, as unbidden guests, 2 small bees (Andrena coitana *K.* ♀, and Halictus cylindricus *F.* ♀) and 3 beetles (1. Antherophagus pallens *Ol.*; 2. Dasytes sp.; 3. Meligethes sp.). Loew (Berlin Botanic Garden), the bee Anthidium manicatum *L.* ♂, creeping right into the flowers and skg. Plateau (Ghent Botanic Garden), 4 bees (1. Bombus terrester *L.*; 2. B. muscorum *F.*; 3. Megachile ericetorum *Lep.*; 4. Anthidium manicatum *L.*), a Sphegid (Oxybelus uniglumis *L.*), a wasp (Odynerus parietum *Pz.*), and a Muscid (Musca domestica *L.*). H. de Vries (Netherlands), the humble-bee Bombus hortorum *L.* ☿ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875). Willis (south coast of Scotland), a Nitidulid beetle (Meligethes sp., freq.), 3 bees (1. Bombus agrorum *F.*, skg.; 2. B. hortorum *L.*, do.; 3. B. terrester *L.*, do.), and a butterfly (Pieris sp., skg.).

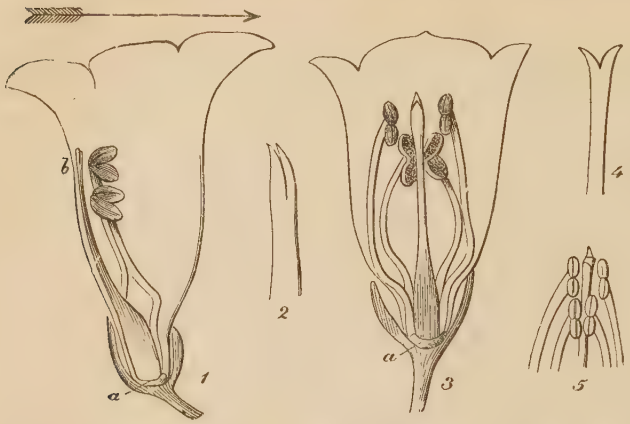


FIG. 291. *Digitalis purpurea*, *L.* (after Herm. Müller). (1) Young flower in which the anthers of the long stamens are dehiscing; seen from the right side after removal of half the calyx and corolla. To bring the figure into the natural position it must be supposed twisted round to the right till the arrow is vertical. (2) End of the style of do., enlarged; the stigmatic lobes are apposed. (3) Somewhat older flower, seen from below after removal of the lower part of calyx and corolla. The anthers of the long stamens have lost their pollen, while those of the short ones have dehisced. (4) End of the style of do., seen from the side; the lobes of the stigma are diverging. (5) Empty anthers and diverging stigmatic lobes of an old flower, seen from below.

2102. D. lutea L. (Herm. Müller, 'Alpenblumen,' pp. 273–5; Schulz, 'Beiträge'; Knuth, 'Bloemenbiol. Bijdragen.')—The flower mechanism of this species agrees essentially with that of D. purpurea, but the corolla-tube is so narrow that only the head of a humble-bee can be inserted into it. As it is 13–14 mm. long the shortest-tongued humble-bees (e. g. Bombus terrester *L.*, with a proboscis 8 mm. long) can only just reach the nectar, while the longest-tongued ones (e. g. B. hortorum *L.*, proboscis 18–21 mm. long) can do so conveniently.

Hermann Müller found the flowers to be markedly protandrous below an elevation of 1000 m. in the Vosges, but in the Suldenthal (1500–1800 m.) the stigma matured at the same time as the anthers of the short stamens, so that automatic self-pollination took place when insect-visits failed.

Schulz found markedly protandrous flowers at Bozen, in the Tyrol, self-pollination being thus excluded. In the same place he noticed stocks which bore small female flowers as well as the hermaphrodite ones, and also very rare instances of gynodioecism.

VISITORS. — Herm. Müller, Schulz, Loew, and Knuth only observed the

humble-bee Bombus hortorum *L.* ♀ and ☿. The first two add that Bombus terrester *L.* ☿ perforates the flowers and steals the nectar.

2103. D. ambigua Murr. (=D. ochroleuca *Jacq.*, and D. grandiflora *Lam.*). (Herm. Müller, 'Alpenblumen,' p. 275, 'Weit. Beob.,' III, pp. 30–1; Kirchner, 'Flora v. Stuttgart,' pp. 585–6; Ludwig, Kosmos, Stuttgart, xvii, 1885; Schulz, 'Beiträge'; Loew, 'Blütenbiol. Floristik,' p. 395.)—The flower mechanism of this species resembles that of D. purpurea. The corolla is dull yellow in colour, and a network of brown lines on the inner surface of the lower lip serves as a nectar-guide. The flower is so broad that humble-bees of any size can conveniently creep into it and suck the nectar. Its entrance is 20–22 mm. broad and 12 mm. high, so that even the smaller bees touch the anthers and stigma, and as protandry is marked cross-pollination is ensured. The same end is further attained by the fact that humble-bees are in the habit of working up the inflorescences from below.

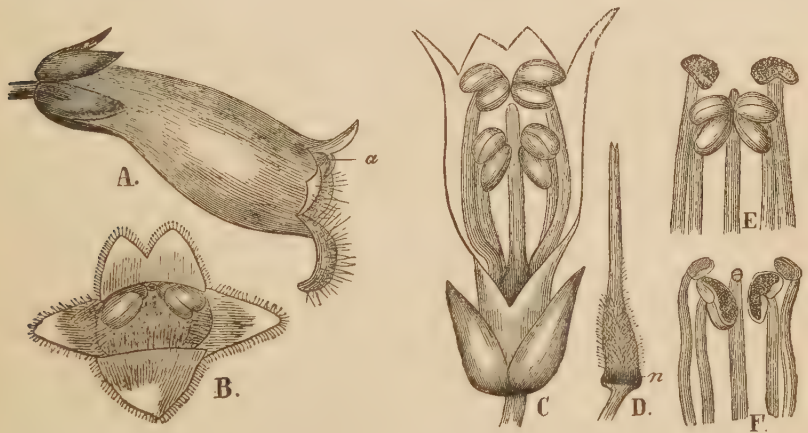


FIG. 292. *Digitalis lutea*, *L.* (after Herm. Müller). *A.* Flower in the first (male) stage, seen from the side. *B.* Do., seen directly from the front. *C.* Do., after removal of most of the corolla, seen from below. *D.* Pistil of do., seen from the side. *E.* Reproductive organs, during the dehiscence of the anthers of the long stamens. *F.* Do., during the dehiscence of the anthers of the short stamens; the two short papillose stigmatic lobes are expanded (× 3½). *a*, anthers of the long stamens; *n*, nectary.

Should insect-visits fail, automatic self-pollination may possibly be effected by pollen still clinging to the anthers.

Besides hermaphrodite plants, Ludwig also observed small-flowered female stocks with reduced vegetative organs, there being 2 % of these at Greiz and Plauen.

VISITORS.—The following were recorded by the observers, and for the localities stated:—

Herm. Müller (Alps), a bee (Anthophora sp.): (Kitzingen), 3 po-cltg. bees—1. Andrena coitana *K.* ♀; 2. Halictus sp. ♀; 3. Dufourea vulgaris *Schenck* ♀. Herm. Müller, jun. (Alps), the humble-bee Bombus hortorum *L.* ♂. Loew (Alt-vatergebirge and Silesia), the last-named humble-bee, ♀, skg. ('Beiträge,' p. 52). Schulz (Tyrol), the humble-bee Bombus terrester *L.*, skg. legitimately and also perforating the flowers. Schletterer and von Dalla Torre (Tyrol), the humble-bee Bombus pomorum *Pz.* ♀.

661. Pentstemon Mitch.

Literature.—Delpino, 'Ult. oss.,' I: Errera, Bull. Soc. roy. bot., Gand, xvii, 1879; Loew, 'Blütenbiol. Beiträge,' I, pp. 31–40, Bot. Centralbl., Cassel, Beih. xvii, 1904, 'D. Bestäubungseinricht. v. Pentastemon Menziesii u. verwandt. Arten,' in Festschr. für Prof. Ascherson, Berlin, 1904; Pasquale, Atti congr. botan. internat., Geneva, (1892) 1893, pp. 553–60; Familler, Inaug.-Dissert., München, 1896; Heinricher, Sitz-Ber. Ak. Wiss., Wien, lxxxvii, 1883; I. Robinson, Öst. bot. Zs., Wien, xlvi, 1896, p. 398.

Protandrous flowers with concealed nectar; stamens and style displaced. The posterior stamen is transformed into a long staminode, sharply bent at its base, and traversing the corolla-tube obliquely until its tip lies on the central lobe of the lower lip.

Comparative studies of as many species as obtainable have recently been made by Loew, with regard to the nectaries and staminode of this genus, which has been the subject of so much oecological work. The material was partly obtained from plants cultivated in the Berlin Botanic Garden, and partly from the herbarium of the Royal Botanic Museum in Berlin. In most species the nectaries are on the outer side of the bases of the two upper filaments, and usually consist of a large number of closely crowded unicellular epidermal papillae, of glandular nature. In some species (e. g. P. Cusickii *A. Gray*, P. diffusus *Dougl.*, P. gracilentus *A. Gray* and P. Rattani *A. Gray*) these papillae are divided by longitudinal septa into two or four daughter-cells, and resemble the stalked glandular trichomes found on the calyx, inflorescence axis, and the vegetative organs of many Pentstemons. The latter, however, possess a much longer stalk-cell, though transitions have been observed between the two kinds of trichome. Herbarium specimens of a number of shrubby Californian species belonging to the section Fruticosi were examined (P. cordifolius *Benth.*, P. ternatus *Torr.*, P. breviflorus *Lindl.*, antirrhinoides *Benth.*, P. Rothrockii *A. Gray* and P. Lemmoni *A. Gray*), and in these the nectar-secreting arrangements differ from that just described. Here there are no glandular papillae on the bases of the two upper filaments. The bases of all four stamens and of the staminodes are greatly broadened, and their margins more or less closely beset with stiff protective hairs. These parts clearly serve as covers for nectar secreted elsewhere, and the nectary is either represented by the well-marked annular hypogynous disk sometimes present or by the base of the corolla. The herbarium material employed did not allow of more accurate determination.

There are great variations within the genus Pentstemon as regards the staminode, as well as with reference to the nectaries, and these are obviously related to the method of pollination. It is sometimes a short useless appendage, sometimes a long glabrous thread. It may be beset with double series of hairs, sometimes in an almost comb-like fashion, or it may possess a unilateral series of short stiff bristles. Its tip may be spatulate or spirally coiled. The height of its insertion is equally variable, for this may be close to those of the fertile stamens or at some distance away. Errera regards the characteristic bend found in many species as an arrangement for obliging visitors to suck the nectar at

the bases of the stamens from a definitive distance. Pasquale, on the other hand, considers that the hairy staminode with a broadened end possessed by P. gentianoides *Poir.* is an organ for receiving the pollen which drops from the anthers, afterwards effecting autogamy by transferring it to the stigma of the same flower, either by spontaneous movement or with the aid of insect visitors. Such an explanation could not apply to species possessing a short staminode incapable of reaching the stigma. In order to explain all these relations, and also the different methods of anther dehiscence and pollen dispersal, a comparative oecological research on numerous species is a desideratum.

2104. P. Hartwegi Benth.—In the Brussels Botanic Garden Errera observed three varieties of this species, and two of

2105. P. gentianoides Poir.—He noticed that all five varieties were visited by the honey-bee, humble-bees, and the hover-fly Eristalis tenax *L.* The bees confined their attention almost entirely to the violet variety of P. gentianoides. Pasquale (op. cit.), however, describes this species as almost exclusively autogamous, pollination by insects scarcely ever taking place. He is of opinion that the descriptions of this which have so far been given rest on inaccurate observations.

2106. P. campanulatus Willd. (Delpino, 'Ult. oss.,' I, pp. 149–50; Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870; W. Ogle, Pop. Sci. Rev., London, ix, 1870, p. 667; Herm. Müller, 'Weit. Beob.,' III, p. 30.)—

Visitors.—The following were recorded by the observers, and for the localities stated.—

Delpino, bees (sp. of Bombus, Anthidium, and Apis). Herm. Müller (in his garden at Lippstadt), the humble-bee Bombus lapidarius *L.* ♀ and ☿, skg. and effecting pollination, and the bee Halictus sexnotatus *K.* ♀, skg.

2107. P. pubescens Ait. (?); **2108. P. ovatus** Dougl.; and **2109. P. confertus** Dougl. (=P. procerus *Dougl.*).—

Visitors.—Loew (Berlin Botanic Garden) observed the honey-bee, which only succeeded in getting nectar in the smallest-flowered species (P. confertus), also 3 po-cltg. bees in the throats of the flowers—1. Andrena combinata *Chr.*; 2. Halictus sexnotatus *K.* ♀; 3. Osmia rufa *L.* ♀.

662. Chelone L.

Literature.—Delpino, 'Ult. oss.,' I.

Protandrous humble-bee flowers. Displacement of stamens and style and secretion of nectar (on bases of upper filaments) as in Pentstemon.

2110. C. glabra L. (Loew, 'Blütenbiol. Beiträge,' I, pp. 28–31.)—This species is native to North America.

Visitors.—Loew (Berlin Botanic Garden) saw the humble-bee Bombus hortorum *L.* ♂.

663. Maurandia Orteg.

Style and stamens displaced as in Pentstemon.

664. Veronica L.

Flowers blue in colour, more rarely red or white; with concealed nectar secreted by a disk below the ovary, and stored in the lower part of the short corolla-tube. The larger blossoms are usually homogamous or dichogamous hover-fly flowers, the stamens and style serving as an alighting-platform. Kerner says that geitogamy takes place in species with a spicate inflorescence.

2111. V. Chamaedrys L. (Sprengel, 'Entd. Geh.,' p. 51; Herm. Müller, 'Fertilisation,' pp. 438–9, 'Alpenblumen,' p. 272, 'Weit. Beob.,' III, p. 31; Kirchner, 'Flora v. Stuttgart,' pp. 586–7; Loew, 'Blütenbiol. Floristik,' p. 391; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 111, 164, 'Bloemenbiol. Bijdragen.')—This species bears homogamous hover-fly flowers, arranged in tolerably conspicuous racemes. The corolla is bright blue, decorated with darker lines and a lighter centre. Nectar is secreted by a fleshy yellow hypogynous disk, and covered by hairs lining the corolla-tube, these serving as a protection against rain. The style is

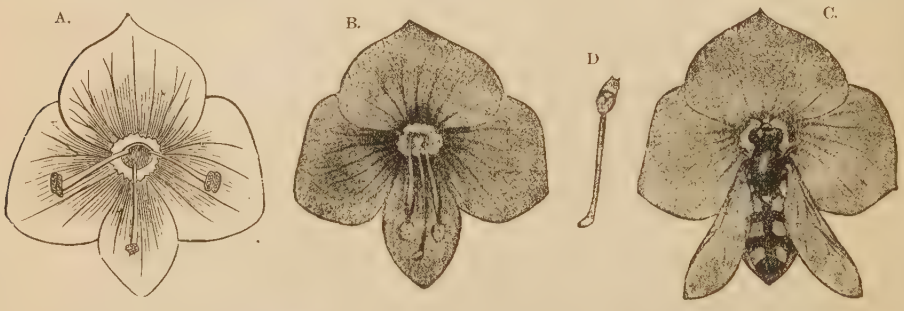


FIG. 293. *Veronica Chamaedrys*, *L.* (*A* after Herm. Müller; *B*, *C*, *D* from nature). *A*. Flower seen from the front. *B*. Do., with the stamens drawn together, as done by a hover-fly. *C*. Do., with a visitor (Ascia podagrica), which has drawn the stamens under its abdomen. *D*. Pistil and nectary (× 3).

directed obliquely downwards, and the two stamens diverge laterally, automatic self-pollination being therefore impossible, although stigma and anthers mature simultaneously. The lower corolla-lobe is the most convenient alighting-platform, so that when an insect settles it must first touch the stigma with its ventral surface. The visitor then seizes the thin bases of the filaments, which are easily drawn together, and its under-side is thus dusted afresh with pollen. In further visits the same procedure is repeated, so that crossing is effected and fresh pollen taken up each time. Even if a hover-fly settles on one of the lateral corolla-lobes the under-side of its abdomen will sometimes be struck by one of the stamens. Kerner finds that automatic self-pollination takes place in the closed flowers during bad weather. He says that the flowers open about 9–10 a. m., closing again about 5–6 p.m.

VISITORS.—Alfken observed the following at Bremen and Hanover.—

A. Coleoptera. *Byrrhidae*: 1. Cistela sericea *Först.* **B. Diptera.** (*a*) *Empidae*: 2. Empis tessellata *F.*, skg. (*b*) *Syrphidae*: 3. Ascia podagrica *F.*, very common, skg.; 4. Syrphus balteatus *Deg.*, skg. **C. Hymenoptera.** (*a*) *Apidae*: 5. Andrena chrysopyga *Schenck* ♂, occasional 6. A. cingulata *F.* ♀ skg. and po-cltg.,

♂ skg., occasional; 7. A. convexiuscula *K.* ♀ and ♂; 8. A. flavipes *Pz.* ♂; 9. A. gwynana *K.* ♀, po-cltg.; 10. A. minutula *K.* ♀ skg. and po-cltg., ♂ skg., very common; 11. A. nitida *Fourcr.* ♀, occasional; 12. A. xanthura *K.* ♂, rare, skg.; 13. Apis mellifica *L.* ☿, po-cltg.; 14. Bombus jonellus *K.* ☿, po-cltg.; 15. Halictus calceatus *Scop.* ♀, skg. and po-cltg.; 16. H. flavipes *F.* ♀, do.; 17. H. leucopus *K.* ♀; 18. H. leucozonius *Schr.* ♀; 19. H. major *Nyl.* ♀ (Hanover); 20. H. minutus *K.* ♀; 21. H. morio *F.* ♀, do.; 22. H. nitidiusculus *K.* ♀, skg. and po-cltg.; 23. H. punctatissimus *Schenck* ♀; 24. H. sexmaculatus *Schenck* ♀; 25. H. sexnotatus *K.* ♀ (Hanover); 26. H. sexnotatulus *Nyl.* ♀, repeatedly, skg. and po-cltg.; 27. H. villosulus *K.* ♀; 28. Nomada flavoguttata *K.* ♀ and ♂, skg.; 29. N. ochrostoma *K.* ♀, skg.; 30. Podalirius retusus *L.* ♂., do. (*b*) *Formicidae*: 31. Lasius fuliginosus *Ltr.* ☿. (*c*) *Sphegidae*: 32. Pompilus viaticus *L.*, freq. **D. Neuroptera.** *Odonata*: 33. Agrion minium *Harr.*, freq., pushing its head into the flowers.

Herm. Müller (H. M.), Buddeberg (Budd.), and Borgstette (Borg.) give the following list for Westphalia, Nassau, and Tecklenburg, respectively.—

A. Coleoptera. (*a*) *Alleculidae*: 1. Hymenalia rufipes *F.*, dvg. the anthers (H. M.). (*b*) *Nitidulidae*: 2. Meligethes sp., freq. forcing its way into the flowers (H. M.). **B. Diptera.** (*a*) *Bombyliidae*: 3. Bombylius canescens *Mik.*, skg. (Budd.). (*b*) *Empidae*: 4. Cyrtoma spuria *Fall.*, skg. (H. M.). (*c*) *Muscidae*: 5. Anthomyia sp., occasional, skg. (H. M.). (*d*) *Syrphidae*: 6. Ascia podagrica *F.*, very common, effecting crossing (H. M.); 7. Melanostoma mellina *L.*, do. (H. M.); 8. Rhingia rostrata *L.*, freq., skg. (H. M., Budd.); 9. Syritta pipiens *L.*, skg. (Budd.). **C. Hymenoptera.** *Apidae*: 10. Andrena cingulata *F.* ♀ and ♂, skg. (Budd.); 11. A. cyanescens *Nyl.* ♀ and ♂, do. (Budd.); 12. A. fulvicrus *K.* ♀, skg. and po-cltg. (H. M.); 13. A. gwynana *K.* ♀, skg. (H. M.); 14. A. minutula *K.* ♀ and ♂, skg. and po-cltg. (Budd.); 15. A. parvula *K.* ♀, po-cltg. (H. M., Thuringia); 16. Apis mellifica *L.* ☿, do. (H. M.); 17. Halictus cylindricus *F.* ♀, skg. (H. M.); 18. H. longulus *Sm.* ♀, do. (H. M.); 19. H. villosulus *K.* ♀, do. (Budd.); 20. H. zonulus *Sm.* ♀, do. (H. M., Thuringia); 21. Melecta armata *Pz.* ♂, do. (H. M., Strasburg); 22. M. luctuosa *Scop.* ♂, do. (Budd.); 23. Nomada germanica *Pz.* ♂, do. (Budd.); 24. Osmia aenea *L.* ♂, do. (H. M., Thuringia); 25. Sphecodes gibbus *L.* ♀, do. (Budd.).

The following were recorded by the observers, and for the localities stated.—

Wüstnei (Alsen), the bee Andrena cingulata *F.* Verhoeff (Norderney), the Muscid Anthomyia muscaria *Zett.* ♀ and ♂, freq., and the Syrphid Melithreptus menthastri *L.* ♂, skg. Schmiedeknecht (Thuringia) and Krieger (Leipzig), the bee Andrena cingulata *F.* Schenck (Nassau), the elegant bees Andrena cingulata *F.* and A. cyanescens *Nyl.* Rössler (Wiesbaden), the Tineid moth Adela fibulella *F.* Friese, 8 bees in Baden (B.), Alsace (A.), Mecklenburg (M.), and Hungary (H.)—1. Andrena chrysopyga *Schenck* ♂ (A.), not rare (M.), occasional (H.); 2. A. chrysoceles *K.*, occasional (M.), rare (H.); 3. A. cingulata *F.*, occasional (B.), freq. (M.); 4. A. cyanescens *Nyl.*, freq. (B., Fiume), not rare (M.); 5. A. labiata *Schenck*, occasional; 6. A. xanthura *K.*, freq.; 7. Nomada corcyrea *Schmiedekn.*, occasional (H.); 8. N. guttulata *Schenck* (H.). Knuth (Kiel), the honey-bee and 4 hover-flies, all skg.—1. Ascia podagrica *L.*; 2. Rhingia rostrata *L.*; 3. Syrphus balteatus *Deg.*; 4. S. pyrastri *L.* Herm. Müller (Alps), 2 hover-flies, 2 Lepidoptera, and a humble-bee. Loew (Brandenburg), the hover-fly Ascia podagrica *F.*, skg., and the bee Andrena cyanescens *Nyl.* ♀, po-cltg. ('Beiträge,' p. 42). H. de Vries (Netherlands), 3 bees—1. Andrena cingulata *F.* ♂; 2. A. parvula *K.* ♀; 3. Apis mellifica *L.* ☿ (Ned. Kruidk. Arch., Nijmegen, 2 Ser., 2 Deel, 1875). MacLeod (Flanders), 4 short-tongued bees, 3 Empids, 4 hover-flies, and 3 Muscids (Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 346–7): (Pyrenees) some short-tongued bees, Bombyliids, and Empids (op. cit., iii, 1891, p. 312). Scott-Elliot (Dumfriesshire), a humble-bee, a hover-fly, and 3 Muscids ('Flora of Dumfriesshire,' p. 130). Saunders (S.) and Smith (Sm.), in

England, 3 bees—1. Andrena cingulata *F.* (S., Sm.); 2. A. parvula *K.* (Sm.); 3. A. minutula *K.* (S.).

2112. V. officinalis L. (Herm. Müller, 'Fertilisation,' p. 441, 'Alpenblumen,' p. 272; Kirchner, 'Flora v. Stuttgart,' p. 587; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 111, 164; Loew, 'Blütenbiol. Floristik,' pp. 391, 399.)—Herm. Müller gives the following account of this species for Westphalia.—The pale-blue flowers are traversed by darker veins. They do not open so widely in the sun as those of V. Chamaedrys. Some flowers are homogamous, others dichogamous. In the former the two stamens are very thin at the base, and project obliquely from the flower at some distance from the underlying style. Nectar is secreted as in the last species, and insect visitors touch the stigma or anthers with various parts of their bodies, effecting self- and cross-pollination indiscriminately. Should insect-visits fail, the filaments twist inwards and downwards as the flowers begin to wither, this being rendered possible by their attenuated bases, until the anthers touch each other and the stigma, thus effecting autogamy.

Stapley observed protandrous flowers in England. When these open the stigma is above the anthers, so that automatic self-pollination is excluded.

Kirchner noticed markedly protogynous flowers at Stuttgart, the style with its mature stigma projecting for about 2 mm. from the still closed corolla. After this expands the anthers do not dehisce for some time, and they are situated above the stigma as in homogamous flowers. Warnstorf states that the flowers are also protogynous at Ruppin, and the style with its mature stigma projects several millimetres from the corolla before they open. He describes the pollen-grains as white in colour, ellipsoidal, with thickened poles, densely beset with small tubercles, up to 50 μ long and 25 μ broad.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Schleswig-Holstein), the hover-fly Syritta pipiens *L.*, skg.; (Thuringia), the Empid Empis truncata *Mg.*, skg. and effecting pollination (Blütenbiol. Beob. in Thüringen,' p. 32). Herm. Müller (Westphalia), an Empid (Empis livida *L.*, freq., skg.), two hover-flies (Helophilus floreus *L.*, skg., and Syritta pipiens *L.*, do.), a small bee (Halictus albipes *F.*, po-cltg.), and 2 parasitic humble-bees—Psithyrus vestalis *Fourcr* ♀, skg., and P. barbutellus *K.* ♀, only skg. for a short time: (Alps), the humble-bee Bombus mendax *Gerst.* ☿, skg. Loew (Brandenburg), the Bombyliid Bombylius minor *L.*, skg., and the Conopid Dalmannia punctata *F.*, do. ('Beiträge,' p. 42): (Switzerland), the hover-fly Syrphus luniger *Mg.* (op. cit., p. 61). MacLeod (Flanders), 4 short-tongued bees, 2 Syrphids, 3 Muscids, and 3 Empids (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 347). Scott-Elliot (Dumfriesshire), a humble-bee ('Flora of Dumfriesshire,' p. 129).

2113. V. montana L. (Herm. Müller, 'Alpenblumen,' p. 272, 'Weit. Beob.,' III, pp. 32–3; Kirchner, 'Flora v. Stuttgart,' pp. 587–8.)—The flower mechanism of this species agrees with that of V. Chamaedrys, but the flowers and inflorescences are larger and more conspicuous, so that insect visitors are more numerous.

Visitors.—Herm. Müller saw the honey-bee and a Sphegid (Ammophila sp.) in the Alps, and in the course of two days he and his son observed the following in Westphalia.—

A. Diptera. (*a*) *Muscidae*: 1. Anthomyia sp., in large numbers, skg. (*b*) *Syrphidae*: 2. Ascia podagrica *F.*, in large numbers, skg.; 3. Syritta pipiens *L.*, do.; 4. Rhingia rostrata *L.*, skg. and po-dvg.; usually drawing the stamens under it while skg. **B. Hymenoptera.** (*a*) *Apidae*: 5. Anthophora retusa *L.* (=A. haworthana *K.*) ♂, skg.; 6. Apis mellifica *L.* ☿, numerous, skg.; 7. Bombus pratorum *L.*: a small ☿, after skg. a single flower, always flew to another raceme; 8. Chelostoma nigricorne *Nyl.* ♂, skg.; 9. Eucera longicornis *L.* ♂, do.; 10. Halictus malachurus *K.* ♀, po-cltg.; 11. H. nitidus *Schenck* ♀, po-cltg.; 12. H. smeathmanellus *K.* ♀, skg.; 13. H. sexnotatus *K.* ♀, do.; 14. H. sexstrigatus *Schenck* ♀, do.; 15. H. zonulus *Sm.* ♀, po-cltg. and skg.; 16. Prosopis confusa *Nyl.*; 17. P. hyalinata *Sm.* ♂, skg.; 18. Psithyrus quadricolor *Lep.* ♀; hangs from below to a raceme, this being pulled down by its weight, and creeps rather slowly from flower to flower, and then flies to another raceme. (*b*) *Sphegidae*: 19. Cerceris variabilis *Schr.* ♀ and ♂, in large numbers, skg.; 20. Passaloecus gracilis *Curt.* (=P. tenuis *Mor.*) ♂, skg.

Scott-Elliot observed 2 hover-flies and 5 Muscids in Dumfriesshire ('Flora of Dumfriesshire,' p. 130).

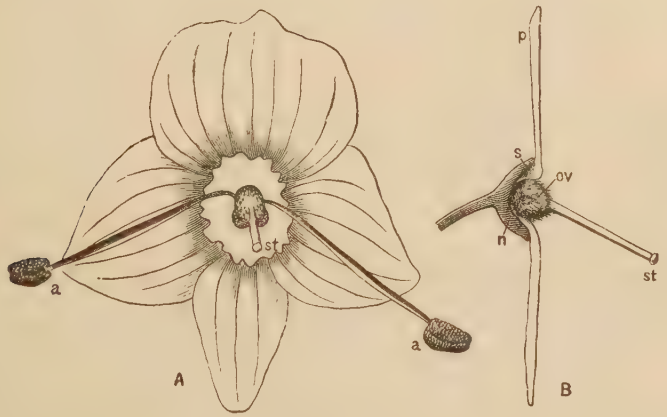


FIG. 294. *Veronica latifolia*, *L.* (after Herm. Müller). *A*. Flower, seen directly from the front. *B*. Do., after removal of half the calyx and corolla, seen from the side. *a*, anthers; *n*, nectary; *ov*, ovary; *p*, petals; *s*, sepals; *st*, stigma.

2114. V. latifolia L. (=V. urticifolia *Jacq.*). (Herm. Müller 'Alpenblumen,' pp. 271–2; Schulz, 'Beiträge'; Knuth, 'Bloemenbiol. Bijdragen.')—The flower mechanism of this species agrees essentially with that of V. Chamaedrys, but the style is shorter, and there are no hairs in the corolla-tube to serve as nectar-covers.

In flowers from the Botanic Garden of the Kiel Ober-Realschule I found the mechanism was not nearly so complete as that of V. Chamaedrys.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel), the honey-bee, freq., and the hover-fly Syrphus ribesii *L.*, less freq. The former only now and then grasped both stamens at the same time; it usually seized the style and one stamen, generally effecting crossing and dusting itself afresh with pollen. Sometimes it settled on two corolla-lobes, and in that case often pushed away the style and one stamen, thus failing to effect pollination, and obtaining the nectar without making any return. Schulz (South Tyrol) flies and small bees.

2115. V. Anagallis L. (MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 347.)—MacLeod says that automatic self-pollination is easily possible in this species.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Heinsius (Belgium), the hover-fly Syritta pipiens *L.* Loew (Silesia), the hover-fly Helophilus lineatus *F.*, skg. Herm. Müller (Thuringia), an Empid (Empis livida *L.*, skg.), a Muscid (Anthomyia sp., skg.), 2 hover-flies (sp. of Ascia and Syritta, skg. and po-dvg.), and an ant (Lasius niger *L.*, nect-lkg.) ('Weit. Beob.,' III, p. 33).

Warnstorf (Verh. bot. Ver., Berlin, xxxviii, 1896) describes the variety *b. aquatica* L. as protogynous. The stamens project a little beyond the stigma, to which the dehiscing anthers are applied, so that self-pollination easily takes place. The pollen-grains are white in colour, ellipsoidal, beset with small tubercles, up to 50 μ long and 20 μ broad.

2116. V. Beccabunga L. (Herm. Müller, 'Fertilisation,' pp. 439–41, 'Weit. Beob.,' III, p. 33; Kirchner, 'Flora v. Stuttgart,' p. 588; Knuth, 'Bloemenbiol. Bijdragen.') — The dark sky-blue flowers of this species are protogynous, and agree with V. Chamaedrys as regards secretion and concealment of nectar. They expand in the sunshine to form a flat surface, from which the stamens diverge upwards and outwards, the anthers being at a distance from the stigma when they dehisce. During unfavourable weather the flowers remain half-closed, and the dehisced anthers keep in contact with the stigma, so that automatic self-pollination takes place.

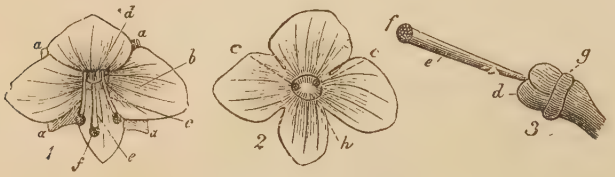


Fig. 295. *Veronica Beccabunga*, *L.* (after Herm. Müller). (1) Flower seen obliquely from above. (2) Corolla after removal of the stamens, seen directly from the front. (3) Pistil and nectary, seen from the side. *a*, sepals; *b*, corolla; *c*, filaments; *d*, ovary; *e*, style; *f*, stigma; *g*, nectary; *h*, nectar-cover. (1 & 2, × 3; 3, × 7.)

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Holstein, Mecklenburg, Pomerania, and Thuringia) and Herm. Müller (Westphalia) describe 2 hover-flies (Syritta pipiens *L.*, and Ascia podagrica *L.*) as the most important visitors. The account given by Müller of their behaviour has been quoted elsewhere (Vol. I, p. 136), and in regard to the present species he speaks as follows: 'The most abundant visitor is a small species of Syrphidae, *Syritta pipiens* L.; hovering backwards and forwards in its jerky flight before the flowers, it suddenly alights on one; sometimes it settles on the projecting style and stamens, which bend beneath its weight, and creeps forward a step or two in order to thrust its proboscis (3 mm. long) into the tube (1 mm.); sometimes it alights on the anterior or one of the lateral petals, and pulls down one of the stamens with its fore-feet until it can reach the pollen with its proboscis. It thus brings various parts of its body in contact with the anthers and stigma, and performs sometimes cross-fertilization, sometimes self-fertilization. Most usually cross-fertilization results, for the insect alighting on the projecting style and stamens usually touches the stigma

with the ventral surface of its body, already dusted with pollen. A smaller species of Syrphidae, *Ascia podagrica* F., visits the flower very abundantly and in a similar way.' Knuth also saw the honey-bee, and the hover-fly Eristalis tenax *L.*, while Herm. Müller gives the following additional list.—**A. Diptera.** (*a*) *Muscidae*: 1. Scatophaga stercoraria *L.*, skg. and po-dvg.; 2. Several small Muscids. (*b*) *Syrphidae*: 3. Ascia podagrica *F.*; 4. Eristalis sepulcralis *L.*, skg. and po-dvg.; 5. Syritta pipiens *L.*, in large numbers, eagerly skg. **B. Hymenoptera.** *Apidae*: 6. Andrena parvula *K.* ♀, skg. and po-cltg.; 7. Apis mellifica *L.* ☿, skg.; 8. Halictus sexstrigatus *Schenck* ♀, skg. and po-cltg. Alfken (Bremen), 5 bees:—1. Andrena minutula *K.* ♂; 2. Halictus calceatus *Scop.* ♀; 3. H. flavipes *F.* ♀; 4. H. minutus *K.* ♀; 5. H. villosulus *K.* ♀. von Fricken (Westphalia and East Prussia), the Chrysomelid beetle Prasocuris junci *Brahm*, and the Curculionid beetle Gymnetron beccabungae *L.* MacLeod (Flanders), 2 short-tongued bees and a hover-fly (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 347). Scott-Elliot (Dumfriesshire), an Empid, 4 hover-flies, and 3 Muscids ('Flora of Dumfriesshire,' p. 129).

2117. V. Teucrium L.—

Visitors.—MacLeod (Pyrenees) observed a bee (Halictus sp.) (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 313).

2118. V. bellidioides L. (Herm. Müller, 'Alpenblumen,' pp. 269–70.) — The dark-blue flowers of this species are homogamous. The bases of the filaments are not attenuated, and the few visitors touch the stigma and anthers in an indiscriminate fashion, effecting either cross- or self-pollination. The latter regularly takes place automatically when insect-visits fail, by contact of the anthers with the stigma.

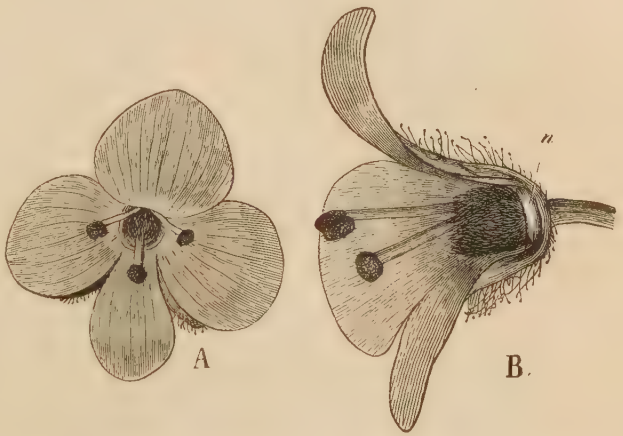


Fig. 296. *Veronica bellidioides*, *L.* (after Herm. Müller). *A.* Flower seen directly from the front (× 4). *B.* Do., from the side, after removal of half the calyx and corolla (× 7). *n*, nectary.

Visitors.—Herm. Müller saw an Empid, a butterfly, and a moth.

2119. V. fruticulosa L. (=V. saxatilis *Scop.*, and V. fruticans *Jacq.*). (Herm. Müller, 'Alpenblumen,' pp. 267–9.)—The blue flowers of this species are homogamous both in the Alps (Herm. Müller) and in Greenland (Warming), and their mechanism is essentially the same as that of V. Chamaedrys, but Hermann Müller observed only occasional and irregular crossing by flies, bees, and Lepidoptera. During dull weather autogamy takes place in the half-closed flowers. (*Cf.* Fig. 297.)

Visitors.—*Vide supra.* MacLeod (Pyrenees) saw a po-dvg. Muscid (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 312–13).

2120. V. spuria L. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 326.)—The flowers of this and the most nearly related species (V. longifolia *L.*, and V. spicata *L.*) are arranged in crowded spikes, and at the beginning of anthesis are adapted by protogyny for cross-pollination. After a few days the stamens of the oldest (i.e. lowest) flowers have elongated so much that their dehiscing anthers occupy the position at first taken up by the stigma. Shortly before dehiscence, however, the style has bent downwards in a knee-like fashion so that automatic self-pollination cannot take place. Later on, when the pollen has been removed by insects or fallen from the shrivelled anthers, the style straightens itself again, and projects almost horizontally from the flower. Since the younger flowers pass through the same stages of anthesis, though of course rather later, pollen can fall from their withering anthers upon the still receptive stigmas of the lower flowers, in which the styles have become horizontal. Geitonogamy is thus effected.

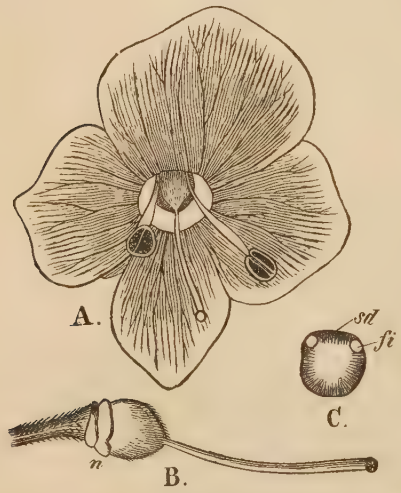


FIG. 297. *Veronica fruticulosa*, *L.* (after Herm. Müller). *A*. Flower seen almost directly from the front (× 4). *B*. Pistil and nectary (*n*) from the side (× 7). *C*. Entrance of the flower showing the nectar-cover (*sd*) and the roots of the filaments (*fi*) (× 7).

2121. V. longifolia L. (=V. maritima *L.*). (Knuth, 'Bloemenbiol. Bijdragen.')—Kerner says that geitonogamy takes place in this species as in V. spuria. In garden plants I found the flowers to possess the same mechanism as the next species (V. spicata), except that they are homogamous. At first the two stamens diverge slightly out of the flower for a distance of 5 mm., and the dehisced surfaces of the anthers are turned downwards. The style is still short and bent downwards in a knee-like way, so that the receptive stigma is out of the line of fall of the pollen. As the anthers shrivel the style elongates and straightens itself, bringing the stigma into pretty much the same position as the anthers at first occupied.

Bee visitors, as they suck the nectar, settle on the lower part of the dense, elongated, conspicuous inflorescence, and work upwards. They thus cross the lower (older) flowers with pollen brought from other stocks, and dust themselves anew in the upper (younger) flowers. Hover-flies when visiting fly from one blossom to another, and mostly effect crossing, but also bring about self-pollination, for, in spite of the deep and concealed position of the stigmas in pollen-containing flowers, these are touched occasionally. Various parts of the visitors' bodies come into contact with anthers and stigma, but they do not draw the stamens under their abdomen, for the filaments are not thin at their bases. Muscids chiefly effect crossing, more rarely autogamy, in an irregular way. The latter cannot take place automatically.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel), all skg. or po-dvg., 2 bees (Apis mellifica *L.* ☿, very freq., and Bombus terrester *L.* ♀ and ☿, freq.), the hover-fly Syrphus ribesii *L.*, and 4 medium-sized Muscids. Saunders (England), the parasitic bee Stelis phaeoptera *K.*

2122. V. spicata L. (Sprengel, 'Entd. Geh.,' pp. 49–50; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 111–13; Herm. Müller, 'Fertilisation,' pp. 441–2, 'Alpenblumen,' p. 272, 'Weit. Beob.,' III, p. 33; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 326.)—Plants of this species brought by me from the island of Röm and cultivated in the Botanic Garden of the Kiel Ober-Realschule are markedly protogynous, and develop from below upwards, so that the lower ones have withered and set fruits before the uppermost ones have opened. Between buds and fruits there is always a zone about 2 cm. long of sexually mature flowers, so that all the stages of anthesis are to be found in the same spike. At the apex are buds (the uppermost still surrounded by the calyx), below which are successively to be found flowers in the female stage, others in the male stage, and finally those in which the sexual organs have withered and fruits are ripening.

The stigma projects from the flower before it has fully opened, and the unripe anthers are still roofed over by the unexpanded upper lobes of the corolla. Expansion then takes place, until the corolla attains a breadth of 8 mm.; the stamens project for

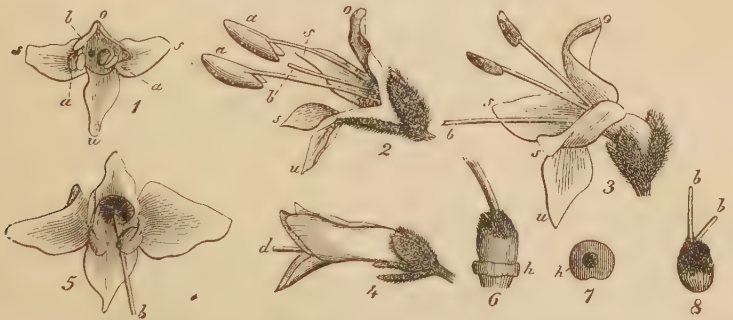


FIG. 298. *Veronica spicata, L.* (after Herm. Müller). (1) Flower shortly before the dehiscence of the anthers (*a*); the stigma (*b*) is still immature, and the stamens project far beyond its upper, lower, and lateral petals (*o*, *u*, and *s*). (2) Do., rather more expanded, seen from the side. (3) Do., after the anthers have withered; the stigma has matured, and is placed below and in front of the stamens. (4) Young flower of another stock; the style already projects, and its stigma (*d*) is tolerably mature, pollen-grains are clinging to it; the anthers are still unripe and concealed within the corolla. (5) Another somewhat older flower from the same stock; the stigma is fully mature, and the anthers have begun to dehisce (× 3½). (6) Ovary and nectary (*h*). (7) Nectary (*h*), seen from above. (8) An ovary with two vestigial styles (*b b*) (× 7).

5 mm. and their anthers dehisce, while the style (8 mm. long) is directed obliquely downwards over the lower corolla-lobe. Kerner says that geitonogamy takes place as in V. spuria and V. longifolia.

Hermann Müller observed that in Thuringia the species varies between protandry and protogyny. In some stocks, as already described, the style projects from the flower before this is fully open, bends downwards, and fully matures its stigma before the anthers dehisce. But in others the anthers project considerably beyond the stigma, which only becomes completely receptive after dehiscence has taken place. Müller also noticed not infrequently flowers with reduced styles, which were sometimes doubled, on stocks of both kinds.

Nectar is secreted by a fleshy disk below the ovary, stored in the corolla-tube (2–3 mm. long), and protected from the entrance of rain-drops by a ring of white hairs. Many insect visitors are attracted by the long conspicuous inflorescences with their blue-violet flowers. Owing to protandry or protogyny, and the projection of the stigma beyond the anthers in the mature stage, these visitors regularly effect cross-pollination.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth, the honey-bee, 2 humble-bees, a Lepidopterid, and 3 hover-flies. Herm. Müller (Westphalia), 2 bees (Apis mellifica *L.* ☿, skg. and po-cltg., and Prosopis communis *Nyl.* ♀ and ♂, freq., skg.) and 3 fossorial wasps (1. Psammophila viatica *L.* ♂, skg.; 2. Cerceris labiata *F.* ♀ and ♂, freq., skg.; 3. C. quinquefasciata *Rossi* skg.): (Thuringia), a hawk-moth (Zygaena carniolica *Scop.*, skg.): (Alps), the honey-bee, and the humble-bee Bombus alticola *Krchb.* ☿, skg. Gerstäcker (Bozen) 3 bees—1. Xylocopa cyanescens *Brull.*; 2. X. valga *Gerst.*; 3. X. violacea *L.* (Ent. Nachr., Berlin, 1872, p. 272). Friese (Hungary), the bee Andrena braunsiana *Friese* ♀ freq., ♂ rare. Schletterer (Tyrol), 5 bees—1. Andrena pectoralis *Pér.* very rare; 2. Bombus argillaceus *Scop.*; 3. B. variabilis *Schmiedekn*; 4. Halictus major *Nyl.*; 5. Xylocopa valga *Gerst.* von Dalla Torre (Tyrol), 2 bees—Halictus major *Nyl.* ♀, and Xylocopa violacea *L.*, ♀ and ♂. Alfken (Bozen), the Scoliid Scolia hirta *Schr.* ♀ and ♂, not infreq., skg., and the bee Xylocopa violacea *L.* ♀, po-cltg.

2123. V. serpyllifolia L. (Herm. Müller, 'Fertilisation,' pp. 443–4; Kirchner 'Flora v. Stuttgart,' p. 590; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The whitish flowers of this species are traversed by veins of a bluish colour. Though usually homogamous, they are sometimes protogynous, or, according to Warnstorf protandrous. The stamens are tolerably close together above, and on either side the stigma, towards which the dehiscing sides of the anthers are turned, sometimes effecting automatic self-pollination. Warnstorf, however, asserts that the stamens project beyond the style, and turn downwards in the open flower during dehiscence so that autogamy is rendered very difficult or entirely excluded. Owing to the close proximity of the stigma and anthers, insect visitors can effect self- as well as cross-pollination.

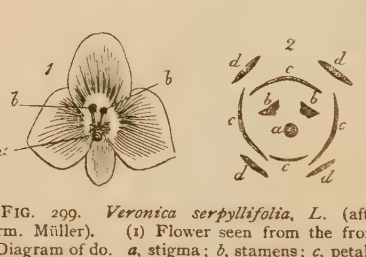


Fig. 299. *Veronica serpyllifolia*, *L.* (after Herm. Müller). (1) Flower seen from the front. (2) Diagram of do. *a*, stigma; *b*, stamens; *c*, petals; *d*, sepals.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (on flowers kept in a room), the Muscid Calliphora erythrocephala *Mg.*, skg.; Scott-Elliot (Dumfriesshire), a Muscid ('Flora of Dumfriesshire,' p. 128).

2124. V. aphylla L. (Herm. Müller, 'Alpenblumen,' pp. 270–1; Schulz 'Beiträge,' II, pp. 117–18.)—The flowers of this species agree with those of V. Chamaedrys in colour, nectar-guides, and the form of the stamens. They are feebly protogynous. Although the bases of the filaments are attenuated, insects which pay visits in sunny weather, touch the anthers and stigma indiscriminately effecting either cross- or self-pollination. The latter inevitably takes place in du

weather when the flowers remain half-closed. Kerner says that anthesis lasts for two days.

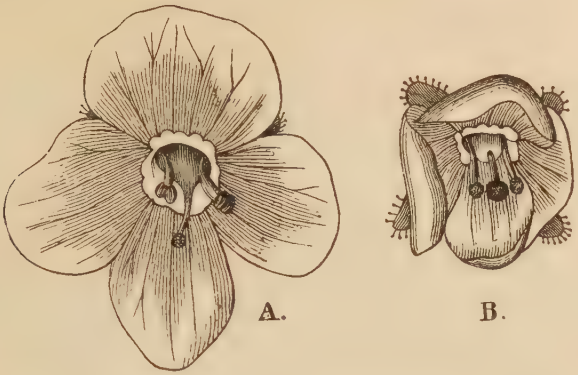


FIG. 300. *Veronica aphylla*, *L.* (after Herm. Müller). *A.* Completely open flower. *B.* Half-closed flower, in which self-pollination is taking place (× 7).

VISITORS.—Herm. Müller observed a Muscid, a Syrphid, and a beetle, on the Stilfser Joch.

2125. V. alpina L. (Herm. Müller, 'Alpenblumen,' p. 270; Schulz, 'Beiträge,' II, p. 117.)—The minute flowers of this species, hardly 4 mm. in diameter, are homogamous, or sometimes feebly protogynous. Lindman found flowers on the Dovrefjeld to be at first protogynous and then homogamous. In Greenland, according to

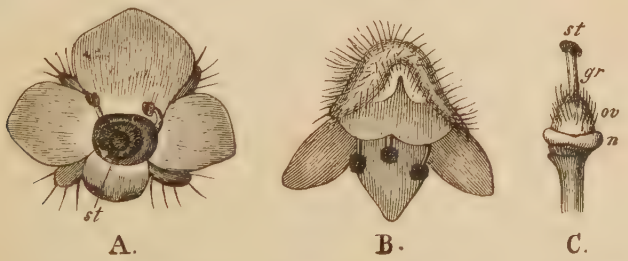


FIG. 301. *Veronica alpina*, *L.* (after Herm. Müller). *A.* Flower seen directly from the front. *B.* Do., from above. *C.* Pistil and nectary (× 7). *gr*, style; *n*, nectary; *ov*, ovary; *st*, stigma.

Warming, the mechanism is the same as in the Alps. During unfavourable weather the flowers remain closed, and autogamy takes place by direct contact of anthers and stigma. Insect-visits are few.

VISITORS.—Herm. Müller only observed a Muscid.

2126. V. arvensis L. (Herm. Müller, 'Weit. Beob.,' III, p. 35; Kirchner, 'Flora v. Stuttgart,' p. 591.)—In this species the dark sky-blue corolla possesses a whitish nectar-guide, and is marked by darker streaks, but there is no nectar-cover. When expanded the flowers are 5 mm. in diameter. The filaments are not attenuated at the base. Anthers and stigma are at the same level, and so close together that

autogamy is easy, while insect visitors effect cross- and self-pollination with equal facility.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Lippstadt), 5 small nect-skg. bees—1. Andrena cingulata *F.* ♀; 2. Halictus albipes *F.* ♀; 3. H. punctatissimus *Schenck* ♀; 4. H. zonulus *Sm.* ♀; 5. Sphecodes gibbus *L.* ♀ and ♂. Schletterer (Pola), 2 bees—1. Halictus calceatus *Scop.*; 2. H. malachurus *K.*

2127. V. peregrina L. (Kirchner, 'Flora v. Stuttgart,' p. 591.)—The small white flowers of this species are devoid of nectar-guides, and generally pseudo-cleistogamous. Even in sunny weather they only open occasionally, and then do not fully expand, for the four lancet-shaped equal corolla-lobes are directed vertically upwards, making a little bell of which the opening is scarcely 1 mm. wide. They are homogamous, and possess neither nectar nor nectar-cover. The style is so short that the stigma is almost sessile, and placed below the two anthers. Automatic self-pollination is inevitable, and as numerous fruits are set is undoubtedly effective.

2128. V. verna L.—

Visitors.—Schletterer (Tyrol) saw the bee Eriades florisomnis *L.*

2129. V. triphyllos L. (Herm. Müller, 'Weit. Beob.,' III, p. 35; Kirchner, 'Flora v. Stuttgart,' p. 590.)—The flowers of this species are homogamous, deep-blue in colour, streaked with darker lines and possessing a white or yellowish centre, but only a feebly developed nectar-cover. The white filaments are not thin at their bases, and the blue anthers are at the same level as the stigma, so that automatic self-pollination is inevitable when the flower closes, as it does in the afternoon and during dull weather. Insect visitors effect cross- or self-pollination irregularly.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Thuringia), 2 bees—Andrena gwynana *K.* ♀, skg., and Apis mellifica *L.* ☿, po-cltg., and (?) skg. Alfken (Bremen), the bee Halictus morio *F.* ♀, skg.

2130. V. agrestis L. (Herm. Müller, 'Weit. Beob.,' III, pp. 33–5; Kirchner, 'Flora v. Stuttgart,' p. 593.)—The mechanism of this species is essentially the same as that of V. Chamaedrys, but is incompletely developed. The scattered homogamous flowers are considerably smaller and therefore less conspicuous, so that automatic pollination often takes place as a last resort. The milk-white corolla has a bluish tinge, and is marked with convergent lines serving as nectar-guides. The nectary, nectar-reservoir, and nectar-cover are as in V. Chamaedrys. The style and stamens project straight out of the flower for the same distance; the latter are somewhat attenuated at the base and curve somewhat outwards. During dull weather the flowers open less widely, so that the anthers and stigma are in contact, automatic self-pollination being thus brought about, and this is undoubtedly effective.

Visitors.—Herm. Müller observed the following in Thuringia.—

A. Diptera. *Muscidae*: 1. Anthomyia sp., skg. **B. Hymenoptera.** *Apidae*: 2. Andrena parvula *K.*, skg. and po-cltg.; 3. Apis mellifica *L.* ☿, po-cltg.; 4. Bombus agrorum *F.* ♀, skg. for a short time.

2131. V. opaca Fries (= V. agrestis *L.*, according to the *Index Kewensis*). (Herm. Müller, 'Weit. Beob.,' III, p. 33.)—

Visitors.—Herm. Müller observed the long-tongued bee Osmia rufa *L.* ♂, skg., in Westphalia.

2132. V. Tournefortii C. C. Gmel. (= V. persica *Hort.*, and V. Buxbaumii *Tenore*). (Kirchner, 'Flora v. Stuttgart,' p. 592.)—Kirchner states that the sky-blue flowers of this species are homogamous, opening about 8–9 a.m., and closing again about 5–6 p.m. The anthers and filaments are blue in colour, and the latter are rather thin at the base. The style is bent somewhat downwards. In a completely open flower the two forwardly directed stamens diverge about 3 mm. from each other. But when a flower does not open completely the anthers lie close to the stigma, and automatic self-pollination takes place.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Kirchner, the butterfly Vanessa urticae *L.* Schletterer and von Dalla Torre (Tyrol), the bee Andrena denticulata *K.* ♀. Burkill (Yorkshire coast)—**A. Diptera.** (*a*) *Muscidae*: 1. Lucilia cornicina *F.*; 2. Sepsis nigripes *Mg.* (*b*) *Phoridae*: 3. Phora sp. **B. Hymenoptera.** *Apidae*: 4. Andrena clarkella *K.* ♂; 5. A. gwynana *K.* ♀. **C. Lepidoptera.** *Rhopalocera*: 6. Vanessa urticae *L.*

2133. V. didyma Tenore (= V. polita *Fries*). (Kirchner, 'Flora v. Stuttgart,' p. 592.)—The homogamous flowers of this species are blue in colour, with darker veins, and a yellowish-white centre. The filaments are somewhat attenuated at the base and white in colour, while the anthers are blue. Secretion of nectar, and nectar-cover, are as in V. Chamaedrys. Only in bright sunshine do the flowers open sufficiently to allow the stamens to diverge; generally the corolla-lobes converge so that the anthers and stigma lie close together, thus rendering automatic self-pollination inevitable. Plants cultivated by Kerner on the Blaser (Tyrol) produced seeds capable of germination as late as September.

Visitors.—Kirchner observed the butterfly Vanessa urticae *L.*

2134. V. hederaefolia L. (Herm. Müller. 'Fertilisation,' pp. 442–3, 'Weit. Beob.,' III, p. 33; Kirchner, 'Flora v. Stuttgart,' p. 593.)—The small, solitary, pale flowers of this species are very inconspicuous. The nectary and nectar-cover are as in V. Chamaedrys, but the bases of the filaments are not thinned. When the flowers open the anthers have already dehisced and surround the simultaneously matured stigma, so that even insect-visits in no way favour cross-pollination. Should such visits fail, automatic self-pollination regularly takes place, and Hermann Müller describes it as always effective. In rainy weather the flowers remain closed, and fertilize themselves pseudo-cleistogamously.

Visitors.—Herm. Müller gives the following list.—

A. Coleoptera. *Nitidulidae*: 1. Meligethes sp. (Thuringia). **B. Hymenoptera.** *Apidae*: 2. Andrena parvula *K.* ♀, skg. (Thuringia); 3. Apis mellifica *L.* ☿, casually skg. (Thuringia); 4. Halictus albipes *F.* ♀, numerous, skg. (Thuringia); 5. H. leucopus *K.* ♀, do.; 6. H. lucidulus *Schenck* ♀, skg. (Thuringia); 7. H. nitidiusculus *K.* ♀, very numerous, skg.

Burkill observed the following on the coast of Yorkshire ('Fertilisation of Spring Flowers').—

A. Coleoptera. *Curculionidae*: 1. Apion nigritarse *K.*, skg. **B. Diptera.** *Muscidae*: 2. Sepsis nigripes *Mg.*, skg. **C. Hemiptera.** 3. One sp., skg. **D. Hymenoptera.** (*a*) *Apidae*: 4. Andrena gwynana *K.* ♀, skg. (*b*) *Formicidae*: 5. Formica fusca *L.*, skg. (*c*) *Ichneumonidae*: 6. Two sp., skg. **E. Thysanoptera.** 7. Thrips sp., skg.

2135. V. Ponae Gouan. (MacLeod, 'Pyreneënbl.,' p. 38.)—The flowers of this species are reddish-violet in colour.

Visitors.—MacLeod observed 4 Diptera (a Bombylius, 2 Syrphids, and an Empid) in the Pyrenees.

2136. V. gentianoides Vahl.—

Visitors.—Loew observed the Dermestid beetle Anthrenus scrophulariae *L.* in the Berlin Botanic Garden.

2137. V. Sandersoni. (Ludwig, Biol. Centralbl., Berlin, vi, 1886–7.)—Ludwig describes this species as bearing protandrous flowers, in which at first the corolla is bright red, the filaments and style being also red, and about 7 mm. long. Later on these parts become white, and the style elongates to 13 mm.

665. Paederota L.

2138. P. Bonarota L. (Loew, 'Blütenbiol. Floristik,' p. 50; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 334–5.)—This species is native to Carniola, Carinthia, and adjacent regions. Loew examined cultivated plants, and found the flowers to be homogamous. The corolla-tube is 4 mm. long. Kerner says that the anthers do not at first reach the level of the stigma, but subsequently attain this by elongation of the filaments, so that automatic self-pollination takes place.

2139. P. Ageria L. (Kerner, op. cit., p. 402.)—This species is native to Carniola and Lower Steiermark. Kerner observed plants cultivated in the Innsbruck Botanic Garden to be infertile. Automatic self-pollination is excluded.

666. Wulfenia Jacq.

2140. W. carinthiaca Jacq.—This species is native to Upper Carinthia. Cultivated plants observed by Hildebrand and Loew were protogynous. Self-pollination is possibly excluded.

667. Tozzia L.

Homogamous or feebly protogynous fly flowers; with nectar secreted by the base of the ovary.

2141. T. alpina L. (Herm. Müller, 'Alpenblumen,' pp. 277–9.)—The flowers of this species are homogamous or feebly protogynous. The three lower lobes of the brilliant yellow corolla present dark purple blotches serving as nectar-guides. Nectar is abundantly secreted, and is easily accessible to insects with a proboscis only a few millimetres long. At first the style projects considerably beyond the stamens, so that insect visitors touch the stigma before the anthers. During subsequent growth of

the flower, the style does not elongate at the same rate as the other parts and ultimately come to lie behind the anthers.

Kerner says that a bending of the style in the course of anthesis renders automatic self-pollination possible, by bringing the stigma into contact with pollen that has collected in the hollows of the corolla.

FIG. 302. *Tozzia alpina*, *L.* (after Herm. Müller). *A.* Just opened flower. *B.* Do., seen from the side. *C.* A slightly older flower, after removal of the calyx and part of the corolla. *D.* Fully mature flower. *E.* Do., partly dissected from the side. *F.* Ovary and nectary. *G.* Do., in longitudinal section (× 7). *n*, nectary; *st*, stigma.

VISITORS.—Herm. Müller only observed Diptera (4 Muscids and 4 Syrphids) in the Alps.

668. Melampyrum L.

Homogamous humble-bee flowers, with the nectary in the form of a lobe projecting downwards from the base of the ovary. The upper lip serves as a roof to protect the anthers from rain. In the species with the longest corolla-tubes (M. arvense *L.*, and M. nemorosum *L.*), and which can therefore only be pollinated by the longest-tongued visitors, the bracts are brightly coloured, thus increasing the conspicuousness of the inflorescence. Rathay (Verh. ZoolBot. Ges., Wien, xxxix, 1889) says that these are beset with nectar-secreting trichomes in some species (M. arvense *L.*, M. nemorosum *L.*, M. pratense *L.*, M. barbatum), and that these 'extra-floral nectaries' attract ants.

2142. M. pratense L. (Herm. Müller, 'Fertilisation,' pp. 458–61, 'Weit. Beob.,' III, p. 36; Kirchner, 'Flora v. Stuttgart,' pp. 594–5; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 354–6; Loew, 'Blütenbiol. Floristik,' p. 399; Knuth, 'Blütenbiol. Beob. a. d. Ins. Rügen,' 'Bloemenbiol. Bijdragen.')—The horizontal flowers of this species possess a yellowish-white three-edged corolla-tube 14–15 mm. long, which conceals a large quantity of nectar in its base, rising to a height of 2–3 mm. The nectary expands towards the lower lip into a whitish rounded body, on either side of which runs a nectar-secreting groove. A circlet of converging hairs protects the secretion from rain, which, owing to the protruding lower lip, is able to penetrate into the flowers in spite of their horizontal position. The corolla-tube is widened in front for a distance of 4–5 mm. sufficiently to permit of the easy insertion

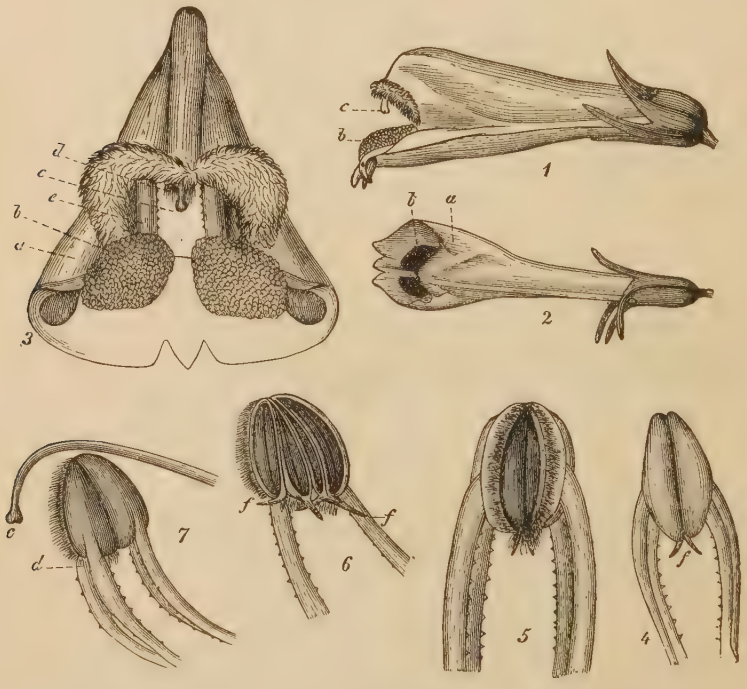


FIG. 303. *Melampyrum pratense, L.* (after Herm. Müller). (1) Flower seen from the side (× 3). (2) Do., from above. (3) Do., from the front (× 7). (4) Pollen-receptacle formed by the anthers, from behind. (5) Do., after opening, from the front. (6) The two stamens of the right half of the flower, seen from the left. (7) Relative position of the stigma and pollen-receptacle. *a*, lateral fold of the anterior part of the corolla; *b*, nectar-guide; *c*, stigma; *d*, hairy covering of the pollen-receptacle; *e*, teeth of the filaments; *f*, spine-like appendages of the anthers.

of the head of a humble-bee. In this widened part a fold projects inwards from the lower part of each side-wall, abutting upon the under-side of the tube so as to reduce the opening of the flower to a breadth of scarcely 3 mm. The height of this is narrowed to 1–2 mm. by two dark-yellow protrusions of the lower lip, serving as nectar-guides, and by a contraction behind the upper lip. But the two lateral folds can be separated by the head of a humble-bee, giving it plenty of room. After the head is thus inserted, a proboscis 10–11 mm. long is required to get at the nectar,

so that all our native humble-bees are able to do this, except Bombus terrester *L.* and, as Herm. Müller adds, the small workers of some other species. Such short-tongued humble-bees, and also the honey-bee, often perforate the flowers and steal the nectar. The filaments adhere to the narrow part of the corolla-tube, becoming free in its widened part, and then running obliquely upwards as broad stiff rods into the hood-like upper lip where the anthers are situated. Their inner sides are beset with short, stiff, tooth-like bristles. The anthers are laterally opposed and make up together a single pollen-receptacle. The anther-lobes are produced downwards into spiny appendages, by the separation of which the pollen-receptacle can be opened. This is practicable because, though the anthers are stiffly united with their filaments and closely apposed along their hinder and upper margins, their lower front edges are only loosely connected by hairs, and therefore easily separate when subjected to slight lateral impact, so that pollen falls out of the receptacle. Should the proboscis of a humble-bee be inserted into the flower and touch one of the spinose anther-appendages it will consequently open the receptacle and get sprinkled with the fine dust-like pollen. The proboscis must be introduced into the corolla-tube exactly in the middle and high up, guided by the soft hairs on the upper lip and anthers. The slightest deviation from this direction would bring its delicate tip into painful contact with the sharp projections on the filaments. If such penetration takes place before the opening of the pollen-receptacle the stigma will be touched, so that the visits of humble-bees to this species ensure crossing. The style runs along the upper edge of the corolla-tube, and bends over the pollen-receptacle; hence the stigma hangs down in the uppermost part of the opening of the flower, between the soft hairs of the upper lip, and will be first touched by the proboscis of a humble-bee, and cross-pollinated if this has previously been dusted with pollen in another flower of the same species.

Should the visits of humble-bees fail, automatic self-pollination takes place as a last resort. The end of the style bends more and more downwards, and finally inwards, so that the stigma is brought under the slits of the pollen-receptacle, which finally open of themselves and pollinate it autogamously.

Lundström says that the bracts continue to secrete nectar and attract ants until the fruits are ripe. In size, shape, colour, and weight, the seeds closely resemble the pupae (so-called 'eggs') of these insects, which remove them from their capsules and carry them to their nests, where germination takes place. (Soc. Scient. Acta, Upsala, Ser. 3, xiii, 1887.)

Visitors.—Herm. Müller (H. M.) and Buddeberg (Budd.) observed the following in Westphalia and Nassau, respectively.—

A. Diptera. *Stratiomyidae*: 1. Oxycera pulchella *Mg.*, vainly searching for nectar, and, apparently, pollen (H. M.). **B. Hymenoptera.** *Apidae*: 2. Apis mellifica *L.* ☿, very freq. (H. M.); 3. Bombus agrorum *F.* ♀ and ☿, skg. legitimately; first carefully inserting its proboscis, and then going to another stock, thus effecting crossing; 4. B. hortorum *L.* ☿, do. (H. M., Siebengebirge); 5. B. lapidarius, ♀ and ☿, freq., stealing nectar by perforation (H. M.); 6. B. pratorum *L.* ♀ and ♂, do. (H. M., Siebengebirge); 7. B. sylvarum *L.* ♀, skg. (H. M., Fichtelgebirge); 8. B. terrester *L.* ♀, freq., behaving as 5. (Luisenburg), vainly trying to suck (Wöllershof in the Bavarian Oberpfalz, H. M.); 9. Megachile circumcincta *K.* ♀, once, skg. legitimately (H. M.).

The following were recorded by the observers, and for the localities stated.—

Knuth (Thuringia), 3 humble-bees—1. Bombus agrorum *F.* ♀ and ☿, skg.; 2. B. hortorum *L.* ♀, do.; 3. B. terrester *L.* ♀, perforating the corolla-tube and stealing nectar: (Rügen), B. hortorum *L.* (coloured like var. tricuspis *Schmiedekn.*), skg. Schmiedeknecht, the humble-bee Bombus mastrucatus *Gerst.* ☿. Alfken (Bremen), 2 bees—Bombus agrorum *F.* ♀, and B. terrester *L.* ♀, perforating the corolla obliquely from above downwards, and stealing nectar. Loew (Silesia), the humble-bee Bombus agrorum *F.* ☿, skg. ('Beiträge,' p. 34): (Switzerland), a Stratiomyid (Sargus flavipes *Mg.*, undoubtedly an unbidden guest) and a hover-fly (Chrysotoxum bicinctum *L.*, do.) (op. cit., p. 62). MacLeod (Flanders), 3 humble-bees and 2 Lepidoptera (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 356). Scott-Elliot (Dumfriesshire), 3 humble-bees ('Flora of Dumfriesshire,' p. 133).

2143. M. arvense L. (Herm. Müller, 'Weit. Beob.,' III, pp. 36–7; Kirchner, 'Flora v. Stuttgart,' p. 596; Schulz, 'Beiträge'; Loew, 'Blütenbiol. Floristik,' p. 399; Knuth, 'Blütenbiol. a. d. Ins. Rügen.')—The inflorescences of this species are very conspicuous, the flowers being of a dull-purple colour with a yellow palate, and the bracts purple-red. Their mechanism agrees with that of M. pratense, but the corolla-tube is longer, 21–2 mm. Their lower part (8–9 mm. long) is vertical, and they are then directed obliquely upwards, finally curving over. The arrangement is that best suited to a humble-bee probing for nectar. A further difference from M. pratense is found in the lower lip, which bends upwards, and loosely applies its margins to those of the upper lip, effecting a closure of the flower that prevents the smaller unbidden guests from creeping in and stealing nectar. Failing the visits of humble-bees, automatic self-pollination takes place as in M. pratense. Short-tongued humble-bees sometimes steal the nectar by perforating the flowers.

Warnstorf describes the pollen-grains as white in colour, spheroidal, striated, about 25 μ in diameter.

Visitors.—Herm. Müller (Thuringia) saw the humble-bee Bombus hortorum *L.* ♀, skg., and also the following, vainly trying to suck.—

A. Coleoptera. *Telephoridae*: 1. Dasytes subaeneus *Schönh.* **B. Diptera.** (*a*) *Conopidae*: 2. Physocephala rufipes *F.* (*b*) *Muscidae*: 3. Ulidia erythrophthalma *Mg.* **C. Hemiptera.** 4. Several undetermined sp. **D. Hymenoptera.** (*a*) *Apidae*: 5. Prosopis armillata *Nyl.* ♂ and ♀, numerous, especially the ♂; 6. Anthophora aestivalis *Pz.* (= A. haworthana *K.*) ♀ (proboscis 15 mm.), vainly trying to get the nectar from a single flower, and then flying away. (*b*) *Chrysididae*: 7. Hedycrum lucidulum *F.* ♂. (*c*) *Ichneumonidae*: 8. Foenus sp. (*d*) *Sphegidae*: 9. Cerceris labiata *F.* ♂; 10. Ceropales albicinctus *Rossi.* (*e*) *Vespidae*: 11. Odynerus minutus *F.* **E. Lepidoptera.** *Rhopalocera*: 12. Melitaea athalia *Rott.*

The following were recorded by the observers, and for the localities stated.—

Loew (Alps), 2 humble-bees: (Switzerland), 2 humble-bees—Bombus rajellus *K.* ♀, skg., and B. variabilis *Schmiedekn.* ♀, do. ('Beiträge,' p. 62). Knuth (Rügen), the humble-bee Bombus terrester *L.*, po-cltg. with large pollen-masses on its tarsi. Buddeberg (Nassau), 2 humble-bees—Bombus agrorum *F.* ♀, and B. sylvarum *L.*; as the proboscis of these is only 15 mm. long they can only make fruitless attempts to suck. Perforation by humble-bees was observed by Schulz; also by Ricca (Atti Soc. ital. sc. nat., Milano, xiv, 1871).

2144. M. nemorosum L. (Herm. Müller, 'Weit. Beob.,' III, pp. 38–9; Schulz, 'Beiträge'; Loew, 'Blütenbiol. Floristik,' p. 395; Knuth, 'Blütenbiol. Beob. a. d. Ins. Rügen.')—The beautiful golden-yellow flowers of this species are very

conspicuous against the handsome blue upper bracts and the dark-green foliage-leaves. Plants are now and then to be found, however, with pale bracts almost white in colour. Such were observed by Hermann Müller in a wood at Kitzingen, and by myself, in similar habitats, on the east coast of Rügen.

The flower mechanism essentially agrees with that of M. pratense, but the corolla-tube is longer, i. e. 18–20 mm. Its first 5 mm. are directed obliquely upwards, and it then bends outwards almost horizontally. The lower lip often lies pretty close to the upper one, though a space of 3–4 mm. is not infrequently left between them.

Individual flowers undergo a change of colour towards the end of anthesis, for the golden-yellow of the under lip and upper part of the corolla-tube changes to a brownish orange-yellow. This does not diminish, perhaps even heightens, the conspicuousness of the entire inflorescence, while at the same time such skilled visitors as humble-bees will learn to avoid these flowers, from which no more booty is to be obtained. As a flower changes colour it bends further downwards, thus bringing the stigma into the line of fall of the pollen, so that automatic self-pollination can take place if crossing has not already been effected.

Short-tongued humble-bees perforate the flowers and steal the nectar.

Visitors.—Herm. Müller saw the following in the Bavarian Oberpfalz (O.), the Fichtelgebirge (F.)., and Thuringia (T.), and at Kitzingen (K.).—

A. Coleoptera. *Telephoridae*: 1. Dasytes sp., creeping into the flowers (O.). **B. Hymenoptera.** *Apidae*: 2. Apis mellifica *L.* ☿, skg. by perforation (K.); 3. Bombus lapidarius *L.* ♀ and ☿, biting a hole a few mm. above the edge of the calyx through the upper edge of the corolla, and skg. (O.); 4. B. hortorum *L.* ☿, skg. legitimately (K., O.); 5. B. agrorum *F.* ☿, as 3. (O.); 6. B. pratorum *L.* ♂ and ♀, skg. by perforation (F.); 7. B. terrester *L.* ♀ and ☿, freq., do. and po-cltg. (K.), ♂, skg. by perforation (F.); 8. Psithyrus rupestris *F.* ♀, do. (F.). **C. Lepidoptera.** (*a*) *Rhopalocera*: 9. Leucophasia sinapsis *L.*, vainly trying to suck (O.); 10. Melitaea athalia *Rott.*, do. (K.). (*b*) *Sphingidae*: 11. Zygaena meliloti *Esp.*, skg. (K.) **D. Thysanoptera.** 12. Thrips, very numerous in its flowers (T., O.).

Loew gives the following list for Brunswick (B.), Steiermark (S.), and the Riesengebirge (R.) ('Beiträge,' p. 53).—

A. Hymenoptera. *Apidae*: all skg.: 1. Apis mellifica *L.* ☿ (R.); 2. Bombus pratorum *L.* ♂ (R.); 3. Megachile circumcincta *K.* ♀, skg. (R.); 4. M. melanopyga *Costa* ♀ (S.); 5. Psithyrus rupestris *F.* ♀ (B.); 6. P. vestalis *Fourcr.* ♀ (B.). **B. Lepidoptera.** (*a*) *Noctuidae*: 7. Plusia gamma *L.*, skg. (R.). (*b*) *Rhopalocera*: 8. Epinephele janira *L.*, skg. (R.).

The following were recorded by the observers, and for the localities stated.—

Knuth (Rügen), 2 humble-bees—Bombus agrorum *F.* ☿, freq., skg., and B. rajellus *K.* ♀, skg. Schmiedeknecht, the humble-bee Bombus mastrucatus *Gerst.* ☿.

2145. M. cristatum L. (Herm. Müller, 'Weit. Beob.,' III, p. 39; Kirchner, 'Flora v. Stuttgart,' p. 595; Schulz, 'Beiträge,' II, p. 217.)—In this species the bright-purple bracts increase the conspicuousness of the inflorescences, though sporadically they may be pale-yellow, as in the Tyrol according to Kerner. The flowers are yellowish in colour, tinged with red, and the lower lip is darker than the rest. Their mechanism essentially agrees with those of the three species already

described, but the corolla-tube is somewhat shorter than in M. pratense, though this does not render the nectar legitimately accessible to shorter-tongued insects than in that species. The corolla-tube rises vertically for 5–6 mm., then bends sharply and runs horizontally for 7–7½ mm. further. It is scarcely 1 mm. broad, though rather more than 1 mm. high, but these dimensions increase to 2 and 4 mm. in front, and it is only into this wide part that the head of a humble-bee can be inserted. A proboscis at least 12 mm. long is therefore necessary to suck out all the nectar. The entrance of unbidden guests is checked by the tolerably close apposition of the lower lip with the hood-like upper one.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (in the wood at Kitzingen), a butterfly (Melitaea athalia *Rott.*, vainly trying to suck) and the humble-bee Bombus lapidarius *L.* ♀ (proboscis 12–14 mm.), skg. legitimately. Schulz saw flowers perforated by humble-bees.

2146. M. sylvaticum L. (Sprengel, 'Entd. Geh.,' pp. 315–16; Herm. Müller, 'Weit. Beob.,' III, pp. 39–41; Schulz, 'Beiträge,' II, p. 218; Loew, 'Blütenbiol. Floristik,' p. 399.)—In this species the tube of the small dark-yellow corolla is about 1 mm. wide. It ascends obliquely for about 3 mm., and then bends horizontally to continue 5 mm. further, widening gradually as it does so and finally dividing into a roof-like upper lip with margins fringed by soft dependent threads, and a three-lobed under lip serving as an alighting-platform. There is no constriction of the entrance to the flower as in other species of the genus, but it widens fairly regularly to an aperture 3 mm. high and broad. The filaments lie close against the outer wall of the corolla-tube and bend together under the upper lip, so that the anthers are close together behind the hairy part of this, and turn their dehisced surfaces downwards. The style lies between the filaments and behind the anthers, and its end bends forwards and downwards, bringing the stigma into the entrance of the flower. The proboscis of an insect probing for nectar must therefore first touch the stigma and then the pollen-covered surfaces of the anthers, thus effecting crossing. Hermann Müller was unable to find any special nectary; nectar seems to be sparingly secreted by the lowest part of the ovary. Vestiges of nectar-covers appear to be present on the inner wall of the corolla-tube where it bends horizontally.

Automatic self-pollination takes place should insect-visits fail, for the stigma comes to lie under the anthers and gets dusted with pollen. This is not so dry and powdery as it is in M. arvense and other species, and remains clinging for a longer time to the under-side of the dehisced anthers.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Buddeberg (Nassau), the humble-bee Bombus senilis *Sm.* (= B. muscorum *F.*) ♀, skg. Herm. Müller (Bavarian Oberpfalz), the wasp Vespa rufa *L.* ☿, on several flowers. Schulz (Riesengebirge), perforated flowers. Loew (Alps), 3 hover-flies as useless visitors—1. Chrysotoxum octomaculatum *Curt.*; 2. Syrphus luniger *Mg.*, skg.; 3. S. lunulatus *Mg.*

669. Pedicularis L.

Homogamous, rarely protogynous, humble-bee flowers, red or yellow in colour; with nectar secreted by a unilateral swelling on the lower side of the ovary. Ekstam observed no insect-visits in Nova Zemlia (Vet.-Ak. Öfvers., Stockholm, li, 1895).

2147. P. sylvatica L. (Sprengel, 'Entd. Geh.,' pp. 216–17; Hildebrand, Bot. Ztg., Leipzig, xxiv, 1866, p. 73; Ogle, Pop. Sci. Rev., London, ix, 1870, pp. 45–7; Herm. Müller, 'Fertilisation,' pp. 450–4, 'Weit. Beob.,' III, p. 41; Kirchner, 'Flora v. Stuttgart,' p. 597; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 113, 165; Schulz, 'Beiträge,' II, p. 218.)—Hermann Müller corrects the errors and supplies the omissions of Sprengel, Hildebrand, and Ogle, giving the following

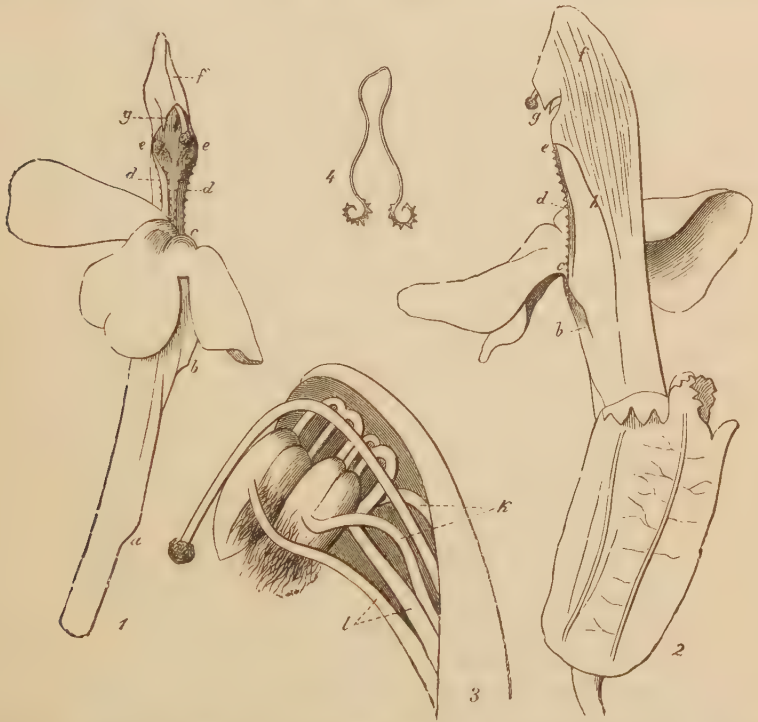


FIG. 304. *Pedicularis sylvatica*, *L.* (after Herm. Müller). (1) Corolla, from the front. (2) Flower, from behind. (3) Upper part of the corolla, from the left side, after part of it has been cut away, and the anthers separated. (4) Transverse section of the corolla at *c* in (1). (1 and 2 × 3½; 4 × 7.) *a*, point of insertion of the anterior stamens; *b*, point of origin of the lower lip; *bc*, lower part of the mouth of the flower, closed by the apposition of the lower lip; *d*, revolute edge of the upper lip, set with teeth; *f*, the hood which surrounds the anthers; *g*, pendulous tip of the hood; *k*, ridge upon the side of the corolla, meeting the revolute border at *e*; *k* and *l*, shorter and longer stamens.

comprehensive account of the mechanism of the rose-red flowers of this species ('Fertilisation,' pp. 450–4).—

'Honey is secreted by the green, fleshy base of the ovary, and lies at the bottom of the tube, which is 10 to 14 mm. long, laterally compressed, and so narrow that a humble-bee can only insert the forepart of its head. At the height of 10 to 14 mm. the tube divides into an upper lip, which both in form and in direction is simply

a continuation of the tube, slightly wider and open in front, and an under lip, whose base (3 to 5 mm. long) is applied to the upper lip so as to close up the lower 3 to 5 mm. of the mouth of the flower. The hooded end of the upper lip encloses the stamens, and the end of the style with the stigma protrudes obliquely downwards from it; the free portion of the under lip with its three lobes serves as a standing-place for insects, and is set very obliquely, so that the right lobe stands 2 to 8 mm. higher than the left (1, Fig. 304). If the under lip is pulled down as far as the place of its attachment, the mouth of the flower is seen to form a fissure 8 to 10 mm. long, which in the greater part of its length is only 1 to 2 mm. broad, but which 3 mm. below its upper end widens out suddenly to a breadth of 4 mm. (*e*, *e*, 1); it then again narrows suddenly, and a little more than 1 mm. from its upper end two sharp processes of the hood (*g*, 1, 2) almost meet in the middle and divide the entrance into a very small upper and a long lower part. Through the upper opening protrudes the style, which springing from the bilocular ovary lies close to the posterior wall of the corolla, and curves sharply downwards near its anterior end to bear the capitate stigma; the long, lower opening admits the bee's head. So long as this slit is only 1 to 2 mm. broad, viz. from the insertion of the under lip to the wider part above, its edges are very markedly rolled outwards, and that part of the inner wall of the corolla which is brought by this revolution of the edge to form the margin of the narrow slit is closely set with sharp points (*d*, 1, 2, 4), while the wider portion (*e*, 1) has smooth edges. There is also on each side of the upper lip a reddish thickened band (*h*, 2), which begins on a level with the wide part of the slit at the upper end of the reflexed edges (*e*), and forming a sharp angle with the ridge runs backwards and downwards to disappear on a level with the base of the under lip.

'What have all these characters, the compressed base of the under lip, the oblique position of its three-lobed lamina, the reflexed edge of the narrow entrance, its rough edges, the sudden enlargement with its smooth edges, the red stripes at the sides of the upper lip, to do with fertilization by humble-bees? Are they accidents to be neglected, as is done by Hildebrand in his figures in the *Botanische Zeitung*, and by Dr. Ogle in the *Popular Science Review*? Careful observation of an insect visiting the flower makes me think otherwise. The bee comes flying along with outstretched proboscis, and avoiding the toothed edges of the slit, thrusts its proboscis at once in alighting into the widest part of the opening (*e*, 1); the upper part of its head then touches the stigma, which stands scarcely 2 mm. above the wide part of the opening, and the oblique position of the lower lip causes the bee's head also to be placed obliquely; its forefeet grasp the basal part of the lower lip, its middle pair of feet grasp the tube of the flower on a level with the lower lip, and the hindfeet rest upon leaves or other flowers below. Standing in this position, the bee applies its head, which is $2\frac{1}{2}$ to 3 mm. thick and 5 mm. broad, to the (4 mm.) wide part of the entrance, with just so much obliquity as gives it the best chance of entering. And now the edges of the slit, rolled outwards and thereby stiffened (*d*, 1, 2), and the bands on the upper lip (*h*, 2), play their part. Joining above at a sharp angle, they bound, on each side of the upper lip, a triangular surface, which does not bend, but gets pushed outwards by the bee's head. But the points where the reflexed edges and the thickened bands meet are on each side of the wide point of the opening,

and as they separate more and more from one another, the superior angle (*e*, *g*, *e*, 1) of the small part of the entrance above this will be very greatly enlarged, for the sides bounding it are very short, and are forced apart as much as the long sides of the lower opening. The small processes (*g*, 1, 2) which before nearly met, and which held together the two halves of the pollen-receptacle [formed by the union of the four anthers] are forced apart; the anthers, which have a tension outwards in consequence of the peculiar curvature of their filaments (*k*, 1, 3), are freed from the force that held them together below, while they remain fastened together above; they therefore flap apart, and let a little pollen fall on the bee's head, exactly on the spot which came in contact with the stigma scarce a second before. The pollen is saved from being scattered at the sides by vertical hairs on the longer stamens (1, 3) which cover the space between the upper and lower anthers on each side, and project slightly beyond the lower edges.

'*Bombus hortorum* L. (proboscis 20 to 21 mm.) needs to thrust its head a very little way down after inserting it into the wide entrance; but the shorter a bee's proboscis is the more must it force its head down in the lower lip, and if there is not space enough *above* the platform of the lower lip, the latter can be pressed down 3 to 4 mm., as far as *b*, 2; so that bees with a proboscis only 10 mm. long may reach the honey. When the bee flies away, the lower lip springs back into its former position, and the whole mouth of the flower resumes its original state.

'The flower is in this way adapted for all our native species of *Bombus* and *Anthophora*, except *B. terrestris* and small workers of a few other species; but the length of the tube excludes all smaller bees, which if the tube were shorter might carry off the honey without touching the stigma; the hooded upper lip guards the pollen from flies and other insects; but the tube is liable to be bitten through and robbed of its honey by some humble-bees, always on the left side. Such robbery does little or no harm, for bees still visit in a legitimate manner flowers which have been bitten through and robbed. The power of self-fertilization has been completely lost.'

Warnstorf describes the pollen-grains as pale-yellow in colour, tuberculate, up to 43 μ long and 25 μ broad.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller, 7 bees—1. Anthophora retusa *L.* ♀ (proboscis 16–17 mm.), skg. legitimately; 2. B. agrorum *F.* (prob. 12–15 mm.), do.; 3. B. hortorum *L.* ♀ (prob. 20–1 mm.), do.; 4. B. lapidarius *L.* ♀ (prob. 12–14 mm.), do.; 5. B. scrimshiranus *K.* ♀ (prob. 10 mm.), do.; 6. B. sylvarum *L.* ♀ (prob. 12–14 mm.), do.; 7. B. terrester *L.* ♀ (prob. 7–9 mm.), skg. by perforation. Knuth, 2 skg. humble-bees—Bombus lapidarius *L.* ♀, and B. agrorum *F.* Höppner (Bremen), 6 bees—1. Apis mellifica *L.* ☿; 2. Bombus agrorum *F.* ♀; 3. B. muscorum *F.* ♀; 4. B. rajellus *K.* ♀; 5. B. terrester *L.* ♀; 6. Podalirius retusus *L.* ♀ and ♂. Schmiedeknecht, the humble-bee Bombus mastrucatus *Gerst.*, one ♀. Scott-Elliot (Dumfriesshire), 2 humble-bees ('Flora of Dumfriesshire,' p. 133).

2148. P. palustris L. (Herm. Müller, 'Alpenblumen,' pp. 291–3; Kirchner, 'Flora v. Stuttgart,' p. 598; Schulz, 'Beiträge,' II, p. 218; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 113–14; Loew, 'Blütenbiol. Floristik,' p. 399.)—The rose-red flowers of this species agree in the main as to their mechanism with those of

P. sylvatica, but they are almost horizontal, and the corolla-tube is only 10–11 mm. long. Humble-bees with a proboscis 8–9 mm. in length can, therefore, reach the nectar by inserting their heads into the entrance. In correspondence with this, the open slit of the flower above its toothed lower part is scarcely more than ½ mm. wide, so that the proboscis or head of a humble-bee will enlarge it noticeably or even considerably. The edges of the upper lip are thickened above the place where the reflexed margins pass into the outer ridges, and when a humble-bee forces its way into the slit this must be opened right up to the tip, some of the pollen being bound to fall out. The horizontal position of the flower secures that a humble-bee, though its proboscis is inserted at a lower level, shall immediately touch the stigma, effecting pollination if another flower has previously been visited. Pollen is discharged so close to the insect's head that arrangements to prevent it from being wasted at the

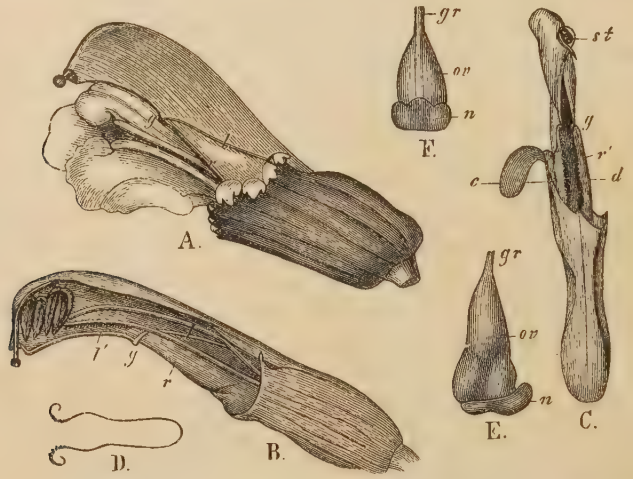


FIG. 305. *Pedicularis palustris*, *L.* (after Herm. Müller). *A*. Flower seen from the left side (× 3½). *B*. Do., after removal of part of the calyx, the lower lip, and most of the left half of the upper lip (× 3½). *C*. Flower seen from the front after removal of part of the calyx and most of the lower lip (× 5). *D*. Transverse section of the upper lip on the line *cd* in *C* (× 7). *E*. Ovary and nectary from the side. *F*. Do., from the front (× 7). *g*, junction of serrated and smooth part of slit in upper lip; *gr*, style; *l'*, thickened edge of upper part of slit; *n*, nectary; *ov*, ovary; *r r'*, reflexed edge of lower part of slit in upper lip; *st*, stigma.

side are unnecessary, and the anthers are consequently glabrous, while the longer filaments are only sparsely beset with hairs.

Warnstorf describes the pollen-grains as white in colour, tuberculate, about 31–5 μ long and 25 μ broad.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Lindman (Dovrefjeld), a humble-bee. Herm. Müller (Alps), the humble-bee Bombus pratorum *L.* ♀. Loew (Alps), the humble-bee Bombus alticola *Krchb.* ☿, skg. ('Beiträge,' p. 62). Heinsius (Holland), 2 humble-bees—Bombus agrorum *F.* ☿, skg. legitimately and regularly effecting pollination; B. scrimshiranus *K.* ☿, perforating the flowers and stealing nectar (Bot. Jaarb. Dodonaea, Ghent, iv, 1892, pp. 109–11). Scott-Elliot (Dumfriesshire), a humble-bee ('Flora of Dumfriesshire,' p. 133). Schulz, the humble-bee Bombus terrester *L.*, perforating the flowers and stealing nectar.

2149. P. recutita L. (Herm. Müller, 'Alpenblumen,' pp. 293–5; Kerner, 'Nat. Hist. Pl.,' Engl. Ed. 1, II, pp. 272–3.)—The lower lip of the red corolla of this species is symmetrically disposed, and only a small part of its base is apposed to the upper one. It possesses a median groove which, according to Hermann Müller, conveniently guides the proboscis of a humble-bee to the nectar in the base of the flower, though Lindman says it is too narrow for this purpose. Humble-bees with a proboscis 8–9 mm. long can suck all the nectar. Kerner speaks as follows of the way in which pollen is discharged (op. cit., pp. 272–3).—

'The anthers in the flowers of this plant are borne on elastic filaments, and are regularly squeezed between the lateral walls of the helmet-shaped upper lip. No separation of the anther-valves is possible unless this lip expands and becomes laterally inflated. This is brought about in a very curious manner. When a humble-bee alights it seizes the projecting upper lip and bends it down through an angle of about 30°, this action being facilitated by the presence of strong ribs at the base of

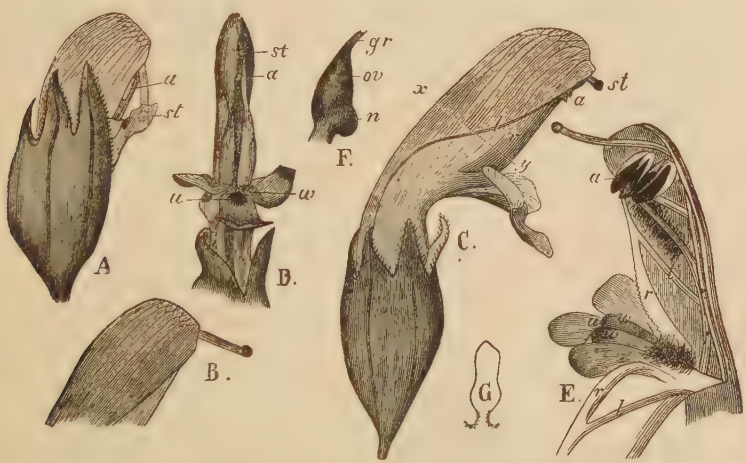


FIG. 306. *Pedicularis recutita*, *L.* (after Herm. Müller). *A.* Flower just before opening, seen from the side. *B.* Upper part of do., after opening. *C.* Mature flower, seen from the side. *D.* Upper part of do., from the front. *E.* Uppermost part of the corolla, the left half having been cut through and bent down. *F.* Ovary and nectary. *G.* Cross-section of upper lip on *xy* in *C* (× 5). *a*, anthers; *gr*, style; *l*, *t*, fold and thickening on side of upper lip; *n*, nectary; *ov*, ovary; *r*, reflexed edge of upper lip; *st*, stigma; *u*, groove on lower lip; *w*, folds bounding do.

the helmet on either side of the throat of the corolla, which act like levers, and communicate their motion to the entire upper lip. In consequence of the inclination of this lip, the sides of the helmet, which up to this time are tightly stretched, bulge out laterally; secondly, the filaments bend in the same sense as the bulging sides of the helmet; and thirdly, the anthers themselves come apart pouring the pollen-dust on to the insect's back. In order that this complicated machinery may do its work successfully, the insect must insert its proboscis at a certain definite spot through a little groove in the under lip, and for this reason all other spots where entrance into the flower might be effected are barricaded. The margin of the upper lip, for instance, is thickly furnished with short-pointed prickles which the insects take care not to touch.'

2150. P. Oederi Vahl. (= P. flammea *Oed.*) (Warming, Bot. Tids., Kjöbenhavn, xvii, 1890, p. 204.)—Warming says that the mechanism of the yellow or whitish-yellow flowers of this northern species agrees in general with that of P. recutita. The tip of the upper lip is coloured dark-red inside. The corolla-tube is 20 mm. long, and possesses a groove running inwards from the middle of the lower lip, as in P. recutita. This does not serve, however, to conduct the proboscis of the insect visitor, which is inserted into a cleft above it, formed by the close approximation of the edges of the upper lip. The stigma generally projects from the upper lip, so that it is first touched by a humble-bee visitor, and pollinated if this comes from another flower. Autogamy, however, often takes place, for the style is not infrequently much shorter, not even attaining the level of the anthers.

Visitors.—Lindman observed several humble-bees.

2151. P. Oederi A. Kern. (= (?) P. flammea *Wulf.*). (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 376–7.)—This species is common on the Brenner in the Tyrol, and Kerner says that the stigma projects in front of the truncated upper lip. The corolla is strengthened by characteristic ribs, which act like a system of levers, and depress the upper lip until at last it is sharply bent down. This movement, of course, involves the style contained in the upper lip, so that the stigma is brought below the anthers instead of being placed above them. At the same time the closely apposed anthers are separated, sprinkling the stigma with pollen. As in P. recutita, crossing is only possible at the beginning of anthesis.

2152. P. foliosa L., and **2153. P. comosa** L. These possess a flower mechanism similar to that of the last species.

2154. P. incarnata Jacq. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 375.)—In this species the anthers are concealed in the upper lip, which is bent at right angles, while the style projects from it, bringing the stigma into the entrance of the flower, so that it must first be touched by visiting humble-bees. As, too, it matures before the anthers, only cross-pollination can take place in this first stage of anthesis. Later on, after dehiscence has taken place, pollen is sprinkled on the heads of insect visitors. Should insect-visits fail, the stamens become limp during the last days of anthesis, the anthers separate, and pollen falls on the inner surface of the tubular bent upper lip. At the same time this becomes more strongly flexed into a vertical position, and the pollen falls down on to the stigma which is placed immediately below. Sometimes as the upper lip is undergoing these changes in position the stigma is drawn into it, and autogamy is effected within its tubular part. Kerner states that a similar mechanism for effecting self-pollination exists in P. asplenifolia *Floerke*, P. Portenschlagii *Saut.*, P. rostrata *L.*, and P. tuberosa *L.*

2155. P. rostrata L. (Ricca, Atti Soc. ital. sc. nat., Milano, xiii, 1870; Herm. Müller, 'Alpenblumen,' pp. 298–300; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 272.)—Hermann Müller says that the lower lip is obliquely disposed in this species, as in P. sylvatica. The anthers are concealed in the vaulted upper lip, and cannot be directly touched by visitors. These are humble-bees, which Kerner says separate the filaments when they force their way into the flowers, so that the smooth anthers are forced apart and pollen is sprinkled on their heads. Automatic self-

pollination is effected by pollen sliding down the narrow part of the upper lip. (*Cf.* P. incarnata.)

FIG. 307. *Pedicularis rostrata, L.* (after Herm. Müller). *A*. Flower seen from the left side (× 3). *B*. Part of the corolla above *x x* in *A*, seen from the right side. *C*. Do., partly dissected, seen from the left side (× 5). *D*. The two stamens, seen from the outer side (× 5). *l*, *m*, lobes of lower lip; *o*, *r*, slit and reflexed edge of upper lip; *st*, stigma.

2156. P. asplenifolia Floerke. (Herm. Müller, 'Alpenblumen,' pp. 300–1; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 376.)—In this species also the lower lip

FIG. 308. *Pedicularis asplenifolia, Floerke* (after Herm. Müller). *A*. Flower, seen from the left side; the arrow points to its entrance (× 3). *B*. Do., after removal of the calyx, lower lip, and left half of the upper lip, seen from the left side. *C*. Ovary (*ov*), nectary (*n*), and base of the style. *D*. End of the style with the stigma. *E*. A pair of stamens (× 7). *F*. Corolla seen from the front, after the removal of the lower lip (× 3).

is oblique, and so markedly that it is almost vertical. The corolla-tube is only 7 mm. long. The upper lip is drawn out into a beak as in P. rostrata. Cross-pollination

is ensured by the projecting stigma, while Kerner says that autogamy can be brought about by the fall of pollen as in P. incarnata *Jacq.* and P. rostrata *L.*

Visitors.—Herm. Müller observed 2 humble-bees and a moth.

2157. P. foliosa L. (Herm. Müller, 'Alpenblumen,' pp. 302–3; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 376.)—In this species the stigma projects from the upper lip, which is not drawn out into a beak. The lower lip is oblique and possesses a median groove. When a humble-bee forces its head into the flower the edges of the upper lip are forced apart, causing the anthers to be separated and pollen to fall on the visitor. Hermann Müller says that automatic self-pollination appears to be excluded, but Kerner asserts that it takes place as in P. recutita *L.*

Visitors.—Herm. Müller saw 3 humble-bees.

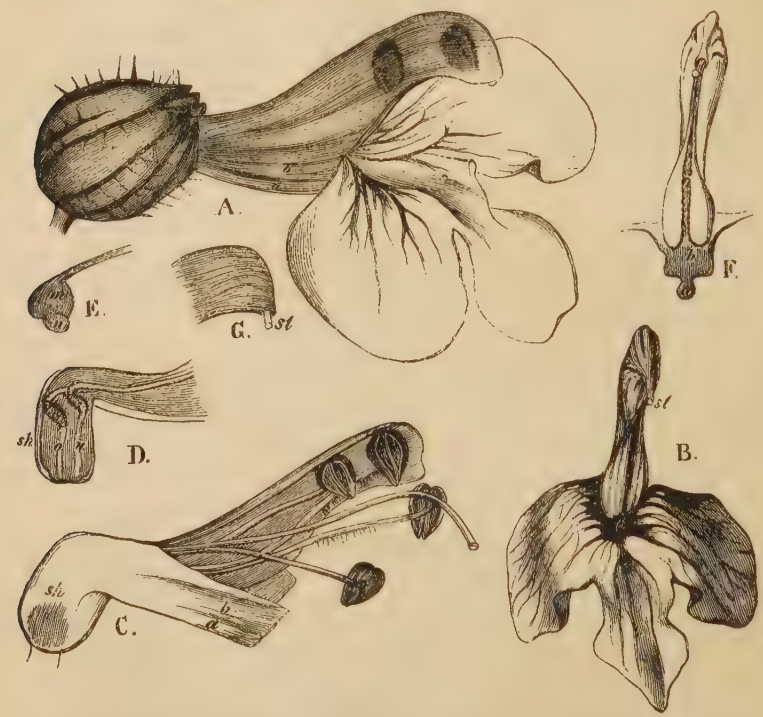


Fig. 309. *Pedicularis verticillata*, *L.* (after Herm. Müller). *A.* Flower seen from the side. *B.*, Do. seen directly from the front. *C.* Flower after removal of the calyx, lower lip, and part of the right half of the rest of the corolla, seen from the right. *D.* Base of the corolla-tube, seen from the right side, in section. *E.* Ovary and nectary. *F.* Upper lip and entrance of the flower, seen obliquely from the front and below. *G.* Tip of the upper lip of an older flower with the projecting stigma, seen from the right side (× 4⅔). *a*, groove in lower lip; *b*, opening of the flower above this; *n*, nectary; *ov*, ovary; *o*, *s*, slit in upper lip; *o*, *u* (in *D*), outer and inner filament; *sh*, base of corolla-tube; *st*, stigma.

2158. P. verticillata L. (Warming, Bot. Tids., Kjöbenhavn, xvii, 1890, p. 215; Herm. Müller, 'Alpenblumen,' pp. 295–8.)—Except that the flowers are horizontal or directed obliquely downwards, their mechanism is similar to that of P. recutita. The head of a humble-bee visitor is pushed along a groove, and forces apart the edges of the upper lip, so that sprinkling of pollen is effected. Hairs on the longer filaments prevent this from being dispersed laterally. The

corolla-tube pursues a straight course for about 3 mm. and then bends at right angles. This not only prevents the abundant nectar from running out, but deters the thievish humble-bee Bombus mastrucatus *Gerst.* from stealing, for it finds it difficult to insert its proboscis round the sharp bend. Self-pollination is excluded.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller, 7 humble-bees, 7 Lepidoptera, and a Bombylius. Loew (Heuthal), the humble-bee Bombus alticola *Krchb.* ☿, skg. ('Blütenbiol. Floristik,' p. 399). MacLeod (Pyrenees), a humble-bee skg. legitimately (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 315).

2159. P. tuberosa L. (Herm. Müller, 'Alpenblumen,' pp. 301–2; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 376.)—The flower mechanism of this species agrees pretty well with that of P. asplenifolia, but the lower lip is not so oblique.

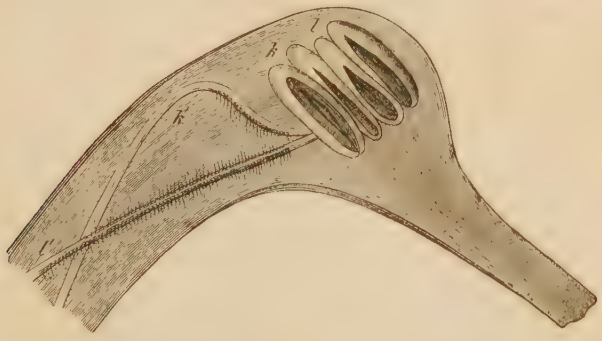


Fig. 310. *Pedicularis tuberosa*, *L.* (after Herm. Müller). Upper lip in longitudinal section. *l l'* and *k k'*, long and short stamens.

The uppermost part of the filaments is beset with hairs to prevent the pollen from being scattered at the side. The corolla-tube is 9 mm. long. Kerner says that autogamy is effected in much the same way as in P. incarnata.

2160. P. lapponica L. (Warming, Bot. Tids., Kjöbenhavn, xvii, 1890, pp. 219–20; Schneider, Tromsø Mus. Aarsh., 1894; Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' p. 42.)—Warming examined this species on the Dovrefjeld, and describes the flowers as smelling like roses, and possessing a mechanism similar to that of P. Oederi *Vahl.* But as the lower lip is still more oblique, it would appear to be more strongly adapted to entomophily than other related forms. In accordance with this, according to Aurivillius, the style is widely exserted, so that insect visitors must first touch the stigma, and thus effect cross-pollination. Owing to the horizontal position of the flower, however, it is perhaps possible for autogamy to be effected by the fall of pollen. Lindman observed ripe fruits, but the plant propagates vigorously by means of subterranean shoots.

Abromeit states that in Greenland the corolla varies from yellowish-white to sulphur-yellow in colour, and is 14–15 mm. long.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Lindman (at a height of 1500 m. on Södra Kundskö), the humble-bee Bombus alpinus *L.* Feilden (Grinnell Land, in Arctic America), numerous humble-bees. Schneider (Arctic Norway), the humble-bee Bombus lapponicus *F.* ♀; and the high arctic butterfly Colias hecla *Lef.*, resting on the flowers.

2161. P. euphrasioides Stev. (Warming, 'Bestövningsmaade,' p. 44, Bot. Tids., Kjöbenhavn, xvii, 1890, pp. 218–19.)—On the Dovrefjeld, according to Warming, the fragrant flowers of this species possess a mechanism similar to that of P. lapponica, but the style does not project so far from the upper lip.

2162. P. flammea L. (Warming, 'Bestövningsmaade,' p. 47; Abromeit, op. cit.)—Warming states that in this species, on the Dovrefjeld, the style is always enclosed in the upper lip, the stigma being just above the anthers, so that self-pollination easily takes place. He observed the formation of fruits.

For Greenland Abromeit describes the corolla as 12–14 mm. long, yellow in colour at the base and in the middle, and with a brown-red upper lip. Fruits were observed to be set on the Karajak nunatak (17. 7. '93).

FIG. 311. *Pedicularis hirsuta*, *L.* (after E. Warming). *A.* Flower seen from the side. *B.* Do., from the front. *C.* Style with stigma. *D*, *F.* Anthers. *G.* Stigmatic papillae. *H.* Pollen-grains, one germinating. *I.* Stigma and anthers in the upper lip. *L*, *P.* Ovary and nectary, from the side. *M*, *P.* Do., from the front. *N.* Peloric form, with 6-lobed corolla, four stamens of equal length, and style. *A*, *B*, *C-F*, and *K-N*, from Greenland material; *I* from Norwegian; *O*, *P*, from Spitzbergen. *A*, *N* (× 3); *F*, *L* (× 8); *O* (× 4).

2163. P. hirsuta L. (Warming, 'Bestövningsmaade,' pp. 44–7; Andersson & Hesselman, 'Bidrag till Känned. om Spetsbergens o. Beeren Eil. Kärlväxtflora'; 'Blütenbiol. Beob. a. Spitzbergen.')—In this species, as in the last three arctic ones and Pedicularis generally, the blossoms are humble-bee flowers in structure. As, however, humble-bees appear to be absent in Spitzbergen, Aurivillius says that the species (like the next one) must have been fertilized autogamously for countless generations. As this has not resulted in diminished vigour or seed production, a

contradiction is afforded to the Knight-Darwin Law that, 'No organic being can fertilize itself through an unlimited number of generations; but a cross with other individuals is occasionally—perhaps at very long intervals—indispensable.' (*Cf.* Vol. I, p. 9.)

In older flowers the style bends so far back that the stigma and anthers touch one another, automatic self-pollination being thus effected. Warming describes this as being effective both in Greenland and Spitzbergen, as shown by the setting of abundant fruits.

With regard to anthesis and the setting of fruits in Spitzbergen the species agrees with P. lanata, according to the observations of Andersson and Hesselman, and also those of Ekstam. Specimens collected by Vanhöffen and Dr. von Drygalski in Greenland possessed, when fresh, a corolla 15 mm. long, pale-red in colour with a deep-red upper lip: a white variety was also noticed. Ripe fruits were also seen at Sermilik as early as July 8 (1892).

2164. P. sudetica Willd. (Warming, Bot. Tids., Kjöbenhavn, xvii, 1890, p. 215.)—For Nova Zemlia Ekstam describes the flowers of this species as red in

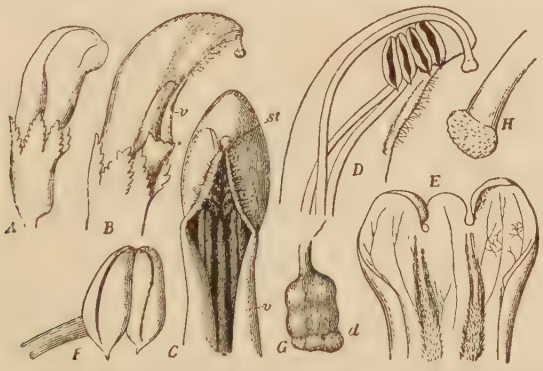


FIG. 312. *Pedicularis Sceptrum-Carolinum*, *L.* (after E. Warming). *A*. Flower in the natural position (×⅔). *B*. Do., after removal of the lower lip (*D*. is part of same in side view after removing part of upper lip). *C*. Part of a flower 25 mm. long, seen from the front; the stigma projects less than in *B*, and the anthers are still undehisced (cf. *F*) (*H* is the tip of the style of the same flower). *E*. Lower lip of *B*. *G*. Ovary and nectary. *d*, nectary; *st*, stigma; *v*, smooth reflexed edge of upper lip.

colour, smelling like jessamine, and protogynous. Autogamy may perhaps be possible, for the projecting persistent stigma lies in the line of pollen fall.

VISITORS.—Ekstam (Nova Zemlia) saw no visitors in 1891, but in 1895 observed a small fly and the humble-bee Bombus hyperboraeus *Schönh.*

2165. P. Sceptrum-carolinum L. (Warming, op. cit., xvii, 1890, pp. 215–18.)—Flowers of this species from the Kola peninsula and Österdalen (Norway) completely agree in their mechanism. Warming describes this as follows from herbarium material.—

'The plant is rendered conspicuous from a distance by the tall greatly branched stem, and the large yellow flowers with their dirty-reddish under-lips. They are much bigger than those of other species, being as much as 32 mm. long, and are vertical in position. The supporting bracts are closely apposed to the stem. Seen from the outside each flower appears to be entirely closed. The lower lip (Fig. 312, *E*)

is vertical, 14–15 mm. long, and closely apposed to the somewhat longer (16 mm.) upper lip so as to close the throat of the corolla. It cannot be entirely depressed. Visitors must obviously be large strong insects, such as humble-bees or hawk-moths, which, much as in Antirrhinum and Linaria, are obliged to force their body or head between the lips before they can touch the stigma. As shown in *B*, the stigma springs forward so far when the lower lip is removed that contact with it must be inevitable. That large insects effect crossing also seems to be indicated by the distance of $2\frac{1}{2}$ cm. between stigma and nectary. I have also several times seen stamens torn out of the upper lip, evidently by the exercise of force on the part of a large insect. One of the flowers figured (*C*) was protogynous, for the anthers were still undehisced while the stigma (*H*) appeared to be mature. On dehiscence subsequently taking place (*D*) a visitor would obviously strike the filaments and sprinkle itself with pollen. It is noteworthy that the filaments, anthers, style, and reflexed edges of the upper lip are all alike glabrous, there being no special arrangement to afford resistance and thus increase the efficiency of the sprinkling-apparatus. But there are hairs on the edges of the superior part of the upper lip, which possibly prevent the pollen from falling on one side, as do the hairs on the anthers of some other species.

There are also variations in the breadth of the slit in the upper lip, and the amount of protrusion of the stigma. The latter may (*B*) project (1–$1\frac{1}{2}$ mm.) or not (as in *C*, or even less). The differences as to the breadth of the opening in the upper lip and the shape of this lip are illustrated by *B* and *C*, Fig. 312. The explanation of these variations I must leave to those who have the opportunity of studying fresh material.

Self-pollination appears to be effected only with difficulty. As even so far north as Alten (70° N. lat.) fruits are set abundantly, Warming is of opinion that crossing must be effected by certain humble-bees.'

2166. P. lanata Cham. (Warming, 'Bestövningsmaade,' p. 47, Bot. Tids., Kjöbenhavn, xvii, 1890, pp. 214–15.)—Warming describes the flower mechanism of this northern species as agreeing with that of P. hirsuta. The automatic self-pollination, which inevitably takes place, is effective in Spitzbergen. And as there are no humble-bees, which alone are strong and clever enough to suck nectar legitimately, what has been said about P. hirsuta applies in a still higher degree to this species.

Andersson and Hesselman ('Bidrag till Känned. om Spetsbergenso. Beeren Eil. Kärlväxtflora,' p. 116) describe the corolla in the var. *dasyantha* Trautw. as being rose-red in colour with a darker tube, and projecting about 12–13 mm. beyond the calyx of 8–9 mm. Ekstam says that the flowers possess a pleasant odour resembling that of almond blossoms, though this is sometimes absent ('Blütenbiol. Beob. a. Spitzbergen,' p. 7). The end of the style does not project from the corolla, but is spirally coiled, while the anthers closely surround the stigma and dehisce on the side turned towards it so that autogamy is inevitable. Flowering begins in Spitzbergen towards the end of June and lasts till August, and fruits are quickly ripened at the end of August or the beginning of September.

670. Castilleja Mutis.

2167. C. pallida Knuth. (Warming, Bot. Tids., Kjöbenhavn, xvii, 1890, pp. 220–3.)—Warming has examined this species from the high North. Only a narrow entrance is left between the vertical lips. There are both long- and short-styled flowers. Autogamy is difficult in the former, but takes place easily in the latter.

671. Rhinanthus L.

Homogamous humble-bee, rarely Lepidopterid flowers (R. angustifolius *C. C. Gmel.*) or humble-bee Lepidopterid flowers (R. major *Ehrh.* var. b) *hirsutus*=the Alpine species R. Alectorolophus *Pollich*). Nectar is secreted by the fleshy base of the ovary which projects to the front, and stored in the bottom of the corolla-tube. Visitors are sprinkled from above with the dusty pollen when they insert their proboscis (not their head also) into the flower. The anthers are protected from rain by the roof-like upper lip. The filaments are beset with sharp points which are

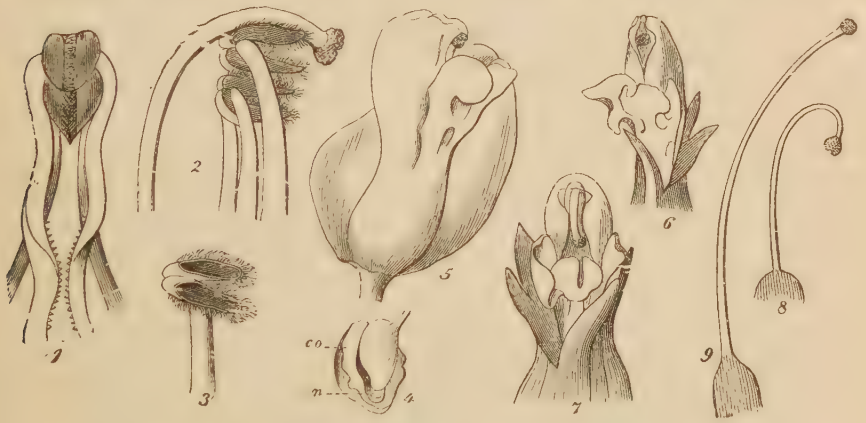


FIG. 313. *Rhinanthus major*, *Ehrh.*, and *R. minor*, *Ehrh.* (after Herm. Müller). (1) Stamens seen from the front. (2) Do., with the style, seen from the side. (3) Inner surface of a stamen. (4) Ovary with base of the style, nectary (*n*), and base of the corolla (*co*). (5) Flower of *R. minor*, after removal of the right half of the calyx, seen from the side. (6) Upper part of do., at the beginning of anthesis, seen from the front. (7) Do., at the end of anthesis. (8) Style of *R. minor*. (9) Do., of *R. major*. (1–3, × 7; 4–9, × 3½.)

avoided by the inserted proboscis. The way to the nectar lies between the anthers, these being covered with soft hairs by which scattering of the pollen at the side is prevented. The persistent dilated and flattened calyx serves less to prevent theft by humble-bees than as a means of catching the wind, so that the contained capsule is moved from side to side and the winged seeds shaken out.

2168. R. major Ehrh. (=R. Crista-Galli var. b *L.*). (Sprengel, 'Entd. Geh.,' p. 313; Herm. Müller, 'Fertilisation,' pp. 454–7; Delpino, 'Ult. oss.,' pp. 130–3; Vaucher, 'Hist. phys. des. pl. d'Europe,' 1871, III, p. 539; Warming, Bot. Tids., Kjöbenhavn, xvii, 1890, pp. 223–6; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 114, 165, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 238.)—The flowers of this species are bright yellow in colour, with violet teeth on the upper lip. The

corolla-tube is 9–10 mm. long, and therefore only accessible to humble-bees with a long or medium proboscis. Short-tongued humble-bees perforate the flowers and steal the nectar. The four anthers lie in the helmet-shaped upper lip, and are united into a sprinkling-apparatus. Each anther is so closely apposed by its margins to the corresponding one on the other side, and dehisces so completely on this surface that the two together make a single pollen receptacle, and interwoven hairs make the closure of this more complete. The two receptacles are borne on stiff filaments of which the anterior ones converge below and are beset with sharp points on their inner sides, but their upper parts are quite smooth, and sufficiently far apart to permit a humble-bee to conveniently insert the end of its proboscis. When the bee forces its way further it separates the filaments, and thus opens the receptacles so that pollen falls directly upon its proboscis, dispersal at the side being prevented by the hairs on the lower edges of the anthers.

The style is closely apposed above to the inner surface of the upper lip, and projects so far out of the flower that the stigma is always first touched by humble-bee visitors, rendering cross-pollination inevitable. Such visitors are very numerous, for the racemose inflorescences are tolerably conspicuous, the effect being heightened by the pale bracts. The style projects straight out of the flower to the end of anthesis, and even elongates, so that automatic self-pollination is impossible. Warnstorf describes the pollen-grains as white in colour, spheroidal when examined in water, smooth, about 56 m. in diameter.

Visitors.—Herm. Müller observed 9 humble-bees.—

1. Bombus hortorum *L.* ♀ and ☿ (proboscis 19–21 mm.), skg. legitimately; 2. B. hypnorum *L.* ☿ (prob. 10–12 mm.), skg. legitimately and po-cltg.; 3. B. muscorum *F.* ♀ and ☿ (prob. 14–15 mm.), do.; 4. B. pratorum *L.* ☿ (prob. 8 mm.), skg. by perforation, and po-cltg.; 5. B. rajellus *K.* ♀ (prob. 12–13 mm.), skg. legitimately; 6. B. sylvarum *L.* ♀ and ☿ (prob. 10–14 mm.), do.; 7. B. scrimshiranus *K.* ☿ (prob. 10 mm.), do.; 8. B. terrester *L.* ♀ and ☿ (prob. 9 mm.), po-cltg. and skg. by perforation; 9. Psithyrus barbutellus *K.* ♀ (prob. 12 mm.), skg. legitimately.

The following were recorded by the observers, and for the localities stated.—

Sprengel, bees and humble-bees. Knuth (Schleswig-Holstein), 4 humble-bees—1. Bombus hortorum *L.* ♀, skg. legitimately; 2. B. cognatus *Steph.* ☿; 3. B. derhamellus *K.* ♀; 4. B. distinguendus *Mor.* ♀: (Rügen), 2 humble-bees (Bombus hortorum *L.* ☿, skg., and B. terrester *L.*, stealing nectar) and the honey-bee, stealing nectar. Alfken (Bremen), 3 humble-bees—1. Bombus arenicola *Ths.* ♀; 2. B. derhamellus *K.*; 3. B. sylvarum *L.* ♀. Schletterer and von Dalla Torre (Tyrol), Bombus derhamellus *K.* H. de Vries (Netherlands), the humble-bee Bombus subterraneus *L.* ♀ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875). MacLeod (Flanders), the humble-bee Bombus hortorum *L.*: (Pyrenees), a moth (Plusia sp.) and 6 humble-bees, skg., also the humble-bee Bombus mastrucatus *Gerst.* as a nectar-thief (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 313–14). Scott-Elliot (Dumfriesshire), 3 humble-bees ('Flora of Dumfriesshire,' p. 132).

Kirchner ('Flora v. Stuttgart,' p. 599) describes as a distinct species the var. *hirsutus* All., and states that its flower mechanism agrees with that of the main type. But Hermann Müller ('Alpenblumen,' pp. 289–91), in his account of Rhinanthus Alectorolophus *L.*, which is identical with the above, says that its flowers are equally adapted to humble-bees and Lepidoptera. They possess, in fact, a 'Lepidopterid door' immediately under the stigma, through which a visiting Lepidopterid can insert

its proboscis and effect crossing; and somewhat below this a 'humble-bee door' which plays the same part as regards humble-bees.

Kerner ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 366) describes the stigma as at first projecting beyond the anthers, so that cross-pollination is effected by insect-visits. Should these fail, the corolla elongates, pushing the epipetalous stamens forward,

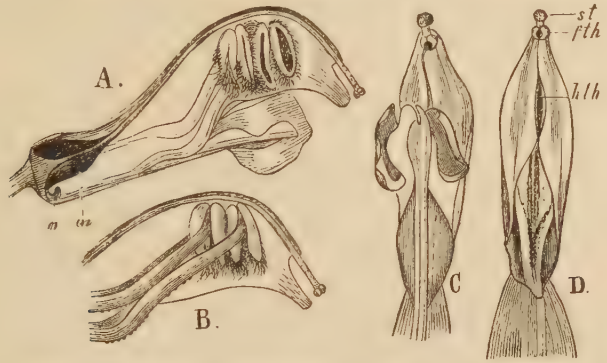


FIG. 314. *Rhinanthus major, Ehrh.*, var. *hirsutus, All.* (after Herm. Müller). *A.* Flower after removal of the calyx, in longitudinal section. *B.* Uppermost part of the flower, after removal of the right half of the corolla, seen from the right side. *C.* Upper part of a flower, seen from the front. *D.* Do., after removal of lower lip (× 3½). *hth*, humble-bee door; *fth*, Lepidopterid door; *n*, nectary; *ov*, ovary; *st*, stigma.

while the stigma remains in its original position. It follows that pollen which has fallen out of the flaccid receptacles and remains clinging to the anther-hairs or the inwardly projecting folds of the corolla will be transferred to the stigma.

VISITORS.—Herm. Müller observed 2 Lepidoptera and 6 humble-bees, Bombus mastrucatus *Gerst.*, among the latter perforating the flowers and stealing nectar.

2169. R. angustifolius C. C. Gmel. (=R. alpinus *Koch*). (Herm. Müller, 'Alpenblumen'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 273, 366.)—This species

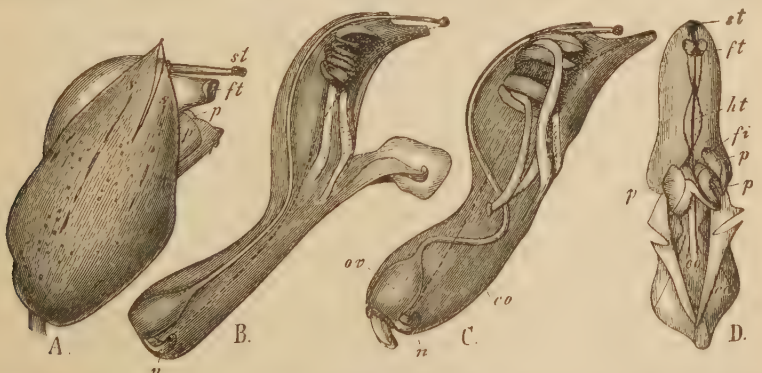


FIG. 315. *Rhinanthus angustifolius, C. C. Gmel.* (after Herm. Müller). *A.* A very young flower, seen from the side. *B.* A somewhat older flower, partly dissected, after removal of the calyx. *C.* A still older flower, partly dissected. *D.* A flower of the same age as *B*, seen directly from the front (× 3½). *ca*, calyx; *co*, corolla; *fi*, filaments; *ft*, 'Lepidopterid door'; *ht*, closed 'humble-bee door'; *n*, nectary; *ov*, ovary; *p*, folds of the corolla; *s s*, sepals; *st*, stigma.

bears protogynous Lepidopterid flowers. The 'humble-bee door' possessed by other species of the genus is closed, but a 'Lepidopterid door' is present, through which only

Lepidoptera can insert their proboscis, it being too narrow for that of other insects. It is situated just under the stigma, which projects a little from the upper lip, and is scarcely one mm. long and ½ mm. broad. The inserted proboscis of a Lepidopterid first touches the stigma, if dusted with pollen depositing some of this upon it, and after being moistened with nectar takes up a fresh supply when withdrawn, should the flower be in the second stage. The proboscis does not touch the stigma during withdrawal, for its pollen-loaded tip at once sinks down. Automatic self-pollination is excluded.

Visitors.—The following were recorded by the observers, and for the localities mentioned.—

Herm. Müller (Alps), 7 sp. of Lepidoptera, of which only two possessed a proboscis sufficiently long to reach the base of the flowers; 10 sp. of humble-bees, which opened the closed 'humble-bee door' by force; and a beetle, dvg. the flowers. Schulz, the humble-bee Bombus terrester *L.*, perforating the flowers and stealing nectar.

2170. R. minor Ehrh. (=Rhinanthus Crista-galli var. a *L.*). (Sprengel, 'Entd. Geh.,' pp. 313–15; Herm. Müller, 'Fertilisation,' pp. 455–6, 'Alpenblumen,' pp. 284–5; Warming, Bot. Tids., Kjöbenhavn, xvii, 1890, pp. 223–6; Schulz, 'Beiträge'; Kirchner, 'Flora v. Stuttgart,' p. 600; Knuth, 'Bloemenbiol. Bijdragen,' p. 53.)—Hermann Müller, for oecological reasons, concurs with the opinion of Linnaeus that this plant and R. major are merely varieties of one and the same species. The mechanism of the two is actually the same, except that in R. minor the smaller and less conspicuous flowers are not so frequently visited by insects, and are capable of automatic self-pollination. The teeth of the upper lip of the golden-yellow corolla are whitish or violet in colour. The corolla-tube is only 7–8 mm. long, so that even our shortest-tongued humble-bee, Bombus terrester *L.* (prob. 7–9 mm. long), can get all the nectar, though the honey-bee (prob. 5–6 mm.) is not able to do so. The entrance of the flower is a slit 6–7 mm. long, which is reduced to about 4 mm. by the closely apposed vertical base of the lower lip. The anthers are placed behind the freely open part of the slit. The style bends so far downwards over these that when the proboscis of a humble-bee is inserted it must first touch the stigma, and then (as in the last species) separate the filaments, causing the part which has just brushed against the stigma to be dusted with pollen. Should humble-bee visits fail, automatic self-pollination takes place, for in the course of anthesis the entrance of the flower widens considerably, for the margins of the upper lip diverge somewhat, while the lower lip bends more downwards. The style elongates proportionately, bringing the stigma under or even between the anthers, which as they wither diverge of themselves.

Visitors.—The following were recorded by the observers, and for the localities stated.—

MacLeod (Pyrenees), the humble-bee Bombus mastrucatus *Gerst.* ☿, perforating the corolla-tube (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 314). Knuth (Schleswig-Holstein), the humble-bee Bombus terrester *L.*, skg. legitimately: (Thuringia), B. agrorum *F.*, skg. Herm. Müller, the same visitors as R. major: (Alps), 4 humble-bees and 3 Lepidoptera. Ekstam (Swedish Highlands), a butterfly (Argynnis sp.). Schulz noticed perforation by humble-bees.

672. Bartsia L.

Homogamous or protogynous humble-bee flowers; with nectar secreted by a cushion-like swelling applied to the lower side of the base of the ovary, and stored up at the bottom of the flower. Long- and short-styled forms occur sporadically. Anemophily is not excluded at a later stage of anthesis.

2171. B. alpina L. (Ricca, Atti Soc. ital. sc. nat., Milano, xiv, 1871; Herm. Müller, 'Alpenblumen,' pp. 283–4; Warming, 'Bestövningsmaade,' pp. 7–10, Bot. Tids., Kjöbenhavn, xviii, 1890, p. 226; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 331; Schulz, 'Beiträge,' II, pp. 118–19.)—Ricca and Hermann Müller state that the flowers of this species are protogynous in the Alps. Their mechanism resembles that of Melampyrum pratense as regards the structure of the corolla, and that of Rhinanthus major as regards the relative position of stigma and anthers. Self-pollination is therefore impossible in Alpine flowers.

The plants observed by Schulz in the Riesengebirge were almost always homogamous or feebly protogamous. When the flower opens, the corolla is 12–16 mm. long; it elongates during anthesis to 17–20 mm., while the style elongates but little. In this way the stigma, which at first projects beyond the anthers, is brought into contact with them, so that automatic self-pollination is inevitable.

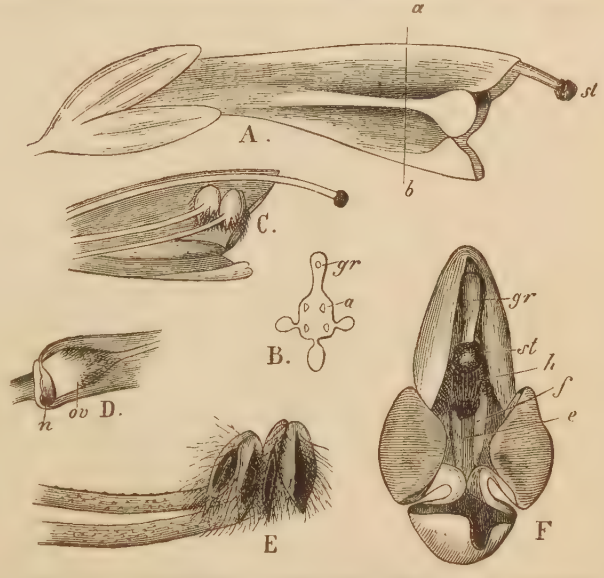


FIG. 316. *Bartsia alpina*, *L.* (after Herm. Müller). *A*. Flower seen from the side. *B*. Cross-section of do. on the line *ab*. *C* and *D*. Upper and lower parts of *A*, partly dissected (× 3½). *E*. The two left anthers, seen from their inner side. *F*. Entrance of the flower, seen directly from the front. *a*, anthers; *e*, entrance; *f*, filaments; *gr*, style; *h*, hairs; *n*, nectary; *ov*, ovary; *st*, stigma.

The plants examined by Lindman on the Dovrefjeld bore homogamous flowers, the stigma and anthers of which matured in the bud. In this case, the end of the style protrudes for a variable distance (1–5 mm.) from the corolla. The anthers are generally enclosed in the flower, which is then dependent upon cross-pollination. Sometimes, however, they grow out of the corolla, and the wind transfers the dry, powdery pollen to the stigma.

The flowers in Greenland were found by Warming to be feebly protogynous, the anthers dehiscing soon after the maturation of the stigma. Both organs then remain functional throughout anthesis. Warming also observed variations in the length of the style, which sometimes projected far out of the flower, but was

sometimes so short that the stigma touched the anthers, and automatic self-pollination consequently took place. Nyhuus found this latter form exclusively at greater elevations near Tromsø on the Dalfjeld, but the long-styled one predominated at stations of lowel level. Kerner says that the flower is at first adapted for crossing, but later on, when the secretion of nectar has ceased, pollination by wind becomes possible. When the style and anthers fade, the pollen which has not yet been removed by insects falls out of the anther-lobes, and is blown away by the wind in little clouds to the still receptive stigmas of younger flowers.

Visitors.—The following were recorded by the observers, and for the localities mentioned.—

Herm. Müller (Alps), 3 humble-bees and 2 Lepidoptera (unbidden guests). Lindman (Alps), humble-bees. MacLeod (Pyrenees), a humble-bee (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 313). Schletterer and von Dalla Torre (Tyrol), the humble-bee Bombus alticola *Krchb.* ♀ and ♂, tolerably freq.

673. Euphrasia L.

Dichogamous, mostly protogynous bee flowers; with concealed nectar, secreted by the lower part of the ovary and stored in the bottom of the corolla-tube.

Fig. 317. *Euphrasia Odontites, L.* (after Herm. Müller). (1) Bud with widely exserted stigma. (2) Flower with stigma near the anthers. (3) Flower with style that has grown far beyond the anthers. (4) Flower with a lateral style (× 3½). (5) The two left stamens, seen from the inner side. (6) Ovary (× 7). *a*, base of the corolla; *b*, nectary; *c*, upper, hairy part of the ovary; *d*, style; *e*, hairs which bind the anthers together; *f*, hairs (sprinkling-hairs) which prevent lateral dispersal of the falling pollen; *g*, prickles which prevent bees from inserting their proboscis between the lower parts of the filaments; *h*, place where the proboscis is introduced.
(2) and (4) are directed more obliquely forward than is represented.

2172. E. Odontites L. (= Bartsia Odontites *Huds.*, and Odontites rubra *Gilib.*). (Herm. Müller, 'Fertilisation,' pp. 445–6; Schulz, 'Beiträge,' II, pp. 119–21; Kerner, Verh. ZoolBot. Ges., Wien, xxviii, 1888; Kirchner, 'Flora v. Stuttgart,' p. 601; Loew, 'Blütenbiol. Floristik,' p. 391; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 115–16, 165, 'Bl. u. Insekt. a. d. Halligen.')—This species bears flowers belonging to class **CH.** The corolla is dirty pink (rarely white) in colour, and there are nectar-guides in the form of purple blotches on the base of the lower lip. The corolla-tube is 4–5 mm. long, and the anthers are situated in its mouth. They almost touch one another, and their inner surfaces are beset with pointed projections.

In the North Frisian Islands, for example (with the exception of the Hallige), the stigma projects from the flower beyond the anthers, so that a bee visitor touches it first, and effects pollination if it has already been to a flower of the same kind. The lower lip serves as a platform. The proboscis is inserted close under the four anthers, so that the bee cannot avoid striking against the tips of some of them, as these are directed obliquely downwards. The anthers are bound together behind by interwoven hairs, and consequently the impact of a bee causes some powdery pollen to be shaken out of all of them. This must of course fall on the visitor's proboscis, for lateral dispersal is prevented by downwardly directed hairs fringing the edges of the anthers.

In the case of plants growing in sunny places, and therefore likely to be much visited by insects, the style with the receptive stigma projects, as already stated, out of the flower, and indeed generally out of the bud when almost ready to open. Even at this stage, therefore, cross-pollination can take place. It is different with plants growing in concealed places or in the shade, or which (as in the Hallige), owing to the scarcity of insects in the neighbourhood, can expect few, if any, visits. In this case the style grows more slowly than the corolla, so that the stigma comes to be placed between the anthers of the longer stamens, and automatic self-pollination is therefore inevitable. This is effective. In plants growing in sunny stations there is a subsequent growth, not only of the corolla, but also of the style, and consequently the stigma always projects beyond the anthers, automatic self-pollination being thus rendered impossible.

Kerner states that the flower mechanism resembles that of Bartsia. He distinguishes (according to Loew, 'Blutenbiol. Floristik,' pp. 296–7) between three stages of anthesis. In the first of these the stigma projects far out of the corolla and is receptive while the anthers are still unripe. By intercalary growth the corolla-tube and filaments elongate until the edge of the upper lip reaches the stigma, under which the anterior anthers are thus brought. Automatic self-pollination is still impossible, for the anterior anthers are bound together by tangled hairs, thus preventing the style from sliding down. In the third stage, the corolla elongates still further, and the stigma is pushed forwards beyond the posterior anthers, which are not bound together, so as to be dusted with their pollen. When the corolla fades, anemophily may also take place, for the slits of the anthers frequently turn outwards, and the wind can carry pollen to the stigmas of flowers at a higher level which are still in the first stage.

Schulz goes so far as to distinguish between five different forms, according to the relative position of anthers and stigma. Several of these forms may frequently be found on the same plant. He groups them as follows.—

A. The style with mature stigma protrudes more or less from the bud.

I. The style continues to elongate during anthesis, so that it always projects a little beyond the corolla, which also continues to grow, and its stigma never comes into contact with the anthers, i.e. cross-pollination is necessary and self-pollination excluded.

(1) The style grows at the same rate as the corolla and stamens, so that it projects just as far beyond the corolla at the end of anthesis as at the beginning.

(2) The style does not grow quite so fast as the corolla and stamens; it projects, therefore, at the most only half as far beyond the corolla at the end of anthesis as at the beginning.

II. The style elongates during anthesis much less rapidly than corolla and stamens, or even does not grow at all, so that the stigma comes into contact with the anthers.

(1) Corolla and stamens elongate little or somewhat slowly, so that the stigma only touches the anthers after it has shrivelled. Cross-pollination is necessary in this case also, and automatic self-pollination excluded.

(2) Corolla and stamens elongate so quickly and to such an extent that stigma and anthers touch soon after dehiscence of the latter. Automatic self-pollination is therefore possible. There is often scarcely any secretion of nectar.

B. The style does not protrude from the bud. The stigma, which is receptive before dehiscence of the anthers, either touches them or stands close in front of them at the beginning of anthesis. Automatic self-pollination is therefore inevitable. There is often scarcely any secretion of nectar.

The first three forms of Schulz correspond, therefore, to Müller's first, and his two last to Müller's second stage.

I was only able to distinguish two forms of the variety *litoralis* Fries (= E. verna *Bell.*), which is found everywhere in the North Frisian Islands. These two forms agree essentially with those of Müller. One of them is adapted exclusively for cross-pollination, but the other is capable of automatic self-pollination.

The flower mechanism of the above-named variety completely agrees with that of the main type in other respects.

Visitors.—Alfken observed the following bees, all skg.—

Juist—Bombus muscorum *F.* ♀, ☿ and ♂, very common, skg. Bremen—1. Bombus arenicola *Ths.* ☿ and ♂; 2. B. lapidarius *L.* ☿ and ♂; 3. B. muscorum *F.* ♀, ☿ and ♂; 4. B. sylvarum *L.* ☿ and ♂; 5. B. terrester *L.* ☿ and ♂; 6. B. variabilis *Schmiedekn.* ☿ and ♂.

The following were recorded by the observers, and for the localities stated.—

Knuth (Schleswig-Holstein), the honey-bee and 2 humble-bees—Bombus agrorum *F.*, and B. lapidarius *L.*; all skg. Herm. Müller, the honey-bee (skg., sometimes above and sometimes below the stamens; also breaking into unopened flowers with projecting styles) and 2 humble-bees, skg.—Bombus lapidarius *L.* ♀ and ☿, and B. sylvarum *L.* ♀ and ♂. Loew (Mecklenburg), the humble-bee B. sylvarum *L.* ☿, skg. and po-cltg. ('Beiträge,' p. 43). Friese (Mecklenburg, *teste* Brauns), the bee Andrena denticulata *K.*, rare: (Alsace, Fiume, Mecklenburg, Thuringia, Saxony, and Hungary), the bee Melitta melanura *Nyl.* von Dalla Torre (Tyrol), the humble-bee Bombus muscorum *F.* ♂. Schletterer (Tyrol), the humble-bee B. variabilis *Schmiedekn.* H. de Vries (Netherlands), the humble-bee B. subterraneus *L.* ☿ (Ned. Kruidk. Arch., Nijmegen, 2 Ser., 2 Deel, 1875). MacLeod (Flanders), the honey-bee, 4 humble-bees (almost exclusively ☿), and a hover-fly (Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 350–2). Scott-Elliott (Dumfriesshire), a humble-bee ('Flora of Dumfriesshire,' p. 132).

2173. E. officinalis L. (Sprengel, 'Entd. Geh.,' p. 315; Herm. Müller, 'Fertilisation,' pp. 447–50, 'Alpenblumen,' p. 279, 'Weit. Beob.,' III, p. 35;

Warming, Bot. Tids., Kjöbenhavn, xvii, 1890, pp. 226–7; Kirchner, 'Flora v. Stuttgart,' pp. 602–3; Schulz, 'Beiträge,' II, pp. 121–4; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 352–4; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 114–15, 165.)—This species bears flowers belonging to class **CH**. Here again Hermann Müller distinguishes between two forms, one with large flowers adapted for cross-pollination, and the other with small ones adapted for automatic self-pollination. I could distinguish two such forms in the North Frisian Islands. Kirchner records them for the neighbourhood of Stuttgart, and identifies the first with E. pratensis *Reichb.* (= E. Rostkoviana *Hayne*), and the latter with E. nemorosa *Pers.* Both the small-flowered autogamous and the large-flowered allogamous forms (the latter being visited by a humble-bee) were found by Lindman in Scandinavia. Warming notices the former only in Greenland.

Schulz divides these two main types into no less than seven different forms, i. e.—

A. The style with mature stigma protrudes from the bud. Corolla, stamens, and style grow considerably during anthesis, but more or less proportionately, so that the relative position of stigma and anthers remains unaltered. Cross-pollination is therefore necessary, and automatic self-pollination excluded. The nectary is a large, dark-green, elongated swelling. Flowers generally fairly large. Corolla 8–10 mm. long, 8–9 mm. broad, 7–9 mm. high. (Form I.)

B. The style with mature stigma protrudes from the bud, but scarcely ever so far as in Form I.

(1) The style elongates but little, while corolla and stamens grow considerably, so that the stigma, which by this time is generally no longer receptive, comes to lie close to the anthers. Self-pollination only occasionally possible. Nectary and size of flower as in the preceding form. (Form II.)

(2) The style elongates scarcely at all, but the corolla as a rule very rapidly; the completely persistent stigma consequently reaches up to the bases of the anthers, or even further, during dehiscence. At first, therefore, cross-pollination is possible, and self-pollination later. Nectary less prominent than in Forms I and II. Size of flowers about the same. (Form III.)

C. The style is bent almost at right angles over the upper anthers, so that the stigma, which matures in the bud, is brought in front of the base of the upper, more rarely of the lower anthers.

(1) The stigma retains its original position, for during anthesis corolla and style grow equally, and consequently automatic self-pollination is inevitable from the first. Nectary often completely absent, and therefore the secretion of nectar also. Flowers considerably smaller than in the preceding forms: corolla $5\frac{1}{2}$–7 mm. long, 5–$5\frac{1}{2}$ mm. broad, 5–6 mm. high. (Form IV.)

(2) The stigma is drawn a little closer to the anthers, while the style grows little or not at all. Possibility of self-pollination, formation of nectary, and flower-tissue are the same as in the preceding and the following forms. (Form V.)

D. The stigma lies upon the anthers from the very beginning of anthesis, and usually becomes receptive simultaneously with the dehiscence of the anthers.

Size of flowers, possibility of automatic self-pollination, formation of nectary, and secretion of nectar, as in Forms IV and V.

(1) Corolla and style grow equally during anthesis, or the style a little less than the corolla. (Form VI.)

(2) The style elongates slightly more than the corolla during anthesis, so that towards the end of this the stigma protrudes. (Form VII.)

Schulz says that Form I agrees with Müller's first form completely, and Form VII more or less with his second.

All forms agree as regards the remaining mechanism of the flower. The white or pale-blue corolla is marked with violet streaks converging to the yellow-spotted flower-base, and serving as nectar-guides. The upper lip forms an arched roof, sheltering anthers and nectar from rain, and preventing the bee visitors from inserting their proboscis above the anthers. The lower lobes of the upper anthers are united with the upper lobes of the lower anthers, and the two upper ones are bound firmly together. Hermann Müller states, and Kirchner agrees with him, that the upper lobe

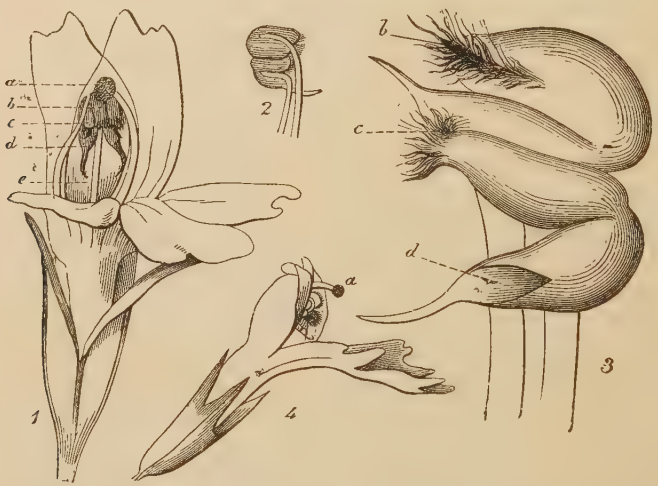


FIG. 318. *Euphrasia officinalis*, *L.* (after Herm. Müller). (1) Flower of the small-flowered form, seen from the front (× 7). (2) The two right stamens, seen from the outer side. (3) Inner side of do., more strongly magnified. (4) Just opened flower of the large-flowered form. *a*, stigma; *b*, upper half of an upper anther; *c*, lower half of do., united with the upper half of a lower anther; *d*, lower half of a lower anther; *e*, style.

of each anther has no point, but the lower one possesses a sharp, stiff spine, and the two lower spines are certainly considerably longer than the upper ones. They project downwards at the entrance of the flower, so that they are struck by bee visitors. Schulz found, in the numerous flowers he investigated, that both lobes of the upper anthers, as well as the upper lobes of the lower ones, always have a short point, and the lower lobes of the latter a much longer one. The smooth and narrow filaments lie close to the sides of the corolla, so that insect visitors can push their heads into the entrance of the flower. In doing so they touch the anther-processes, causing pollen to fall out of the anthers on to the heads of the insects, since lateral dispersal is prevented by the hairs on the upper anthers. Kerner says that in the

large-flowered variety (= E. Rostkoviana *Hayne*) the same kind of automatic self-pollination occurs, by means of further growth of the corolla-tube, as he has described in the case of Rhinanthus hirsutus and R. angustifolius (*cf.* pp. 219, 220). This applies also to Euphrasia tricuspidata *L.* and E. versicolor *A. Kern.* Darwin ('Cross Fertilisation,' p. 368) found E. officinalis fertile by automatic self-pollination. Flower visitors naturally prefer the forms possessing large flowers of striking colour and secreting abundant nectar.

Visitors.—Herm. Müller observed the following, all skg.—

A. Diptera. (*a*) *Bombyliidae*: 1. Systoechus sulphureus *Mik.* (*b*) *Syrphidae*: 2. Melithreptus taeniatus *Mg.*; 3. Syrphus sp. **B. Hymenoptera.** *Apidae*: 4. Apis mellifica *L.* ☿, freq.; 5. Bombus agrorum *F.* ☿; 6. B. pratorum *L.* ☿; 7. Halictus minutissimus *K.* ♀, creeping right into the flowers; 8. Nomada lateralis *Pz.* ♀.

Alfken gives the following list.—

Juist—**A. Diptera.** *Syrphidae*: 1. Syrphus ribesii *L.* **B. Hymenoptera.** *Apidae*: 2. Bombus lapidarius *L.* ☿. skg.; 3. B. muscorum *F.* ☿, do.; 4. Colletes impunctatus *Nyl.*, rare, skg.; 5. C. marginatus *L.*, freq., po-cltg. and skg.; 6. Epeolus variegatus *L.* Bremen, 3 humble-bees, skg.—1. Bombus hortorum *L.* ☿; 2. B. muscorum *F.* ♀, ☿ and ♂; 3. B. lapidarius *L.* ☿.

The following were recorded by the observers, and for the localities stated.—

Knuth (Röm), the honey-bee and a hover-fly (Helophilus pendulus *L.*); (Thuringia), the humble-bee Bombus soroënsis *F.*, var. proteus *Gerst.* ☿. Hoffer (Steiermark), the parasitic bee Psithyrus rupestris *F.* ♀. Friese (Innsbruck), the bee Halictoides paradoxus *Mor.* ♀ (in the large-flowered variety). von Dalla Torre (Tyrol), 2 humble-bees—Bombus agrorum *F.*, and B. soroënsis *F.* (also by Schletterer in the Tyrol). Herm. Müller (Alps, in the large-flowered form), 5 flies, 11 bees, and 8 Lepidoptera. Mac-Leod (Pyrenees, in both forms), a Lepidopterid and a hover-fly (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 314–15). Scott-Elliot (Dumfriesshire), 2 humble-bees, a short-tongued bee, a saw-fly, 4 hover-flies, and a Muscid ('Flora of Dumfriesshire,' p. 132).

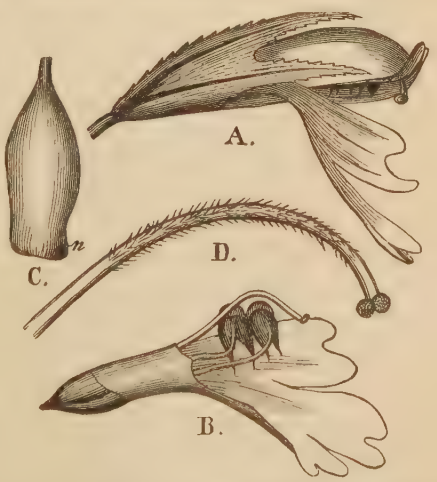


Fig. 319. *Euphrasia salisburgensis, Funk* (after Herm. Müller). *A.* Young flower, seen from the side. *B.* Do., after removal of the upper lip and a large part of the calyx. (× 7.) *C.* Ovary with nectary (*n*). *D.* Uppermost part of the style. (× 16.)

2174. E. salisburgensis Funk (= E. officinalis, according to the *Index Kewensis*). (Herm. Müller, 'Alpenblumen,' pp. 280–1.)—This species bears flowers belonging to class **CH.** They are protogynous, and resemble those of the small-flowered form of E. officinalis in size and conspicuousness. Cross-pollination is effected by insect-visits, owing to the projection of the stigma. Should such visits fail, the stigma frequently moves to the middle of the anthers by continued growth of the corolla, so that automatic self-pollination may be effected.

Visitors.—Herm. Müller saw 2 hover-flies, 3 bees, and 7 Lepidoptera in the Alps.

2175. E. lutea L. (= Odontites lutea *Reichb.*). (Herm. Müller, 'Fertilisation,' p. 447; Kirchner, 'Flora v. Stuttgart,' p. 602.)—This species bears golden-yellow flowers belonging to class **CH**; with a corolla-tube only $2\frac{1}{2}$ mm. long, which is glabrous on the inner side, but beset with small vertical hairs at the entrance, that serve as nectar-covers. The four stamens are remote, but owing to the smallness of the flower they are all touched simultaneously by insect visitors. Hermann Müller says that the flowers are homogamous, though sometimes the style is widely exserted even in the bud; in other cases it protrudes simultaneously with the anthers. Since the stigma is situated under, and in front of the anthers, it is first touched by insect visitors and dusted with foreign pollen. Should such visits fail, automatic self-pollination generally occurs by the falling of pollen on the stigma.

Kerner states that the flower mechanism resembles that of Tozzia. The nectary is (Loew, 'Blütenbiol. Floristik,' p. 297) a longitudinal groove in the base of the ovary. The filaments are strongly bent; the anthers are separate, not bound together by hairs, and provided with a little point directed downwards. In protogynous flowers the already receptive stigma is situated at first in front of the still narrow entrance, and as the anthers are still unripe self-pollination is excluded. In the second stage of anthesis the corolla opens more widely, resembling a Veronica flower. The filaments elongate considerably at the same time, twisting in various ways, and the anthers turn round. The style, however, bends downwards, so that the stigma is pushed under the entrance of the flower, and cannot be brushed against by insects as they enter. In the third stage, the filaments also bend downwards, but the style once more bends upwards, so that the slightest shaking causes pollen to fall on the stigma.

Fig. 320. *Euphrasia lutea*, *L.* (after Herm. Müller). (1) Flower, seen from the side. (2) Do., directly from the front. (3) Bud, seen from the side (× $3\frac{1}{2}$). (4) Stamen.

Visitors.—Herm. Müller observed the humble-bee Bombus agrorum *F.* ☿, skg.

2176. E. minima Jacq. (= E. officinalis *L.*, according to the *Index Kewensis*). (Herm. Müller, 'Alpenblumen,' pp. 281–3; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, 353; Schulz, 'Beiträge,' II, pp. 124–5.)—This species bears yellow flowers belonging to class **CH**. Hermann Müller says that they essentially resemble those of the small-flowered form of E. officinalis as regards their mechanism and the course of their development. Cross-pollination by means of insect-visits is ensured by the prominent position of the stigma at an early stage. If such visits fail, the style elongates and bends down under the anthers, so that pollen falls on the stigma, and automatic self-pollination is effected.

Schulz states that in most cases the stigma is already fully matured in the bud, lying under the upper and even under the lower anthers, and generally reaching up

towards the upper anthers later, for the style does not grow during anthesis at the same rate as the corolla. Automatic self-pollination is in any case inevitable towards the end of anthesis.

Kerner, however, did not observe elongation of the corolla, but says that towards the end of anthesis the style bends so far downwards as to bring the stigma into the line of fall of the pollen.

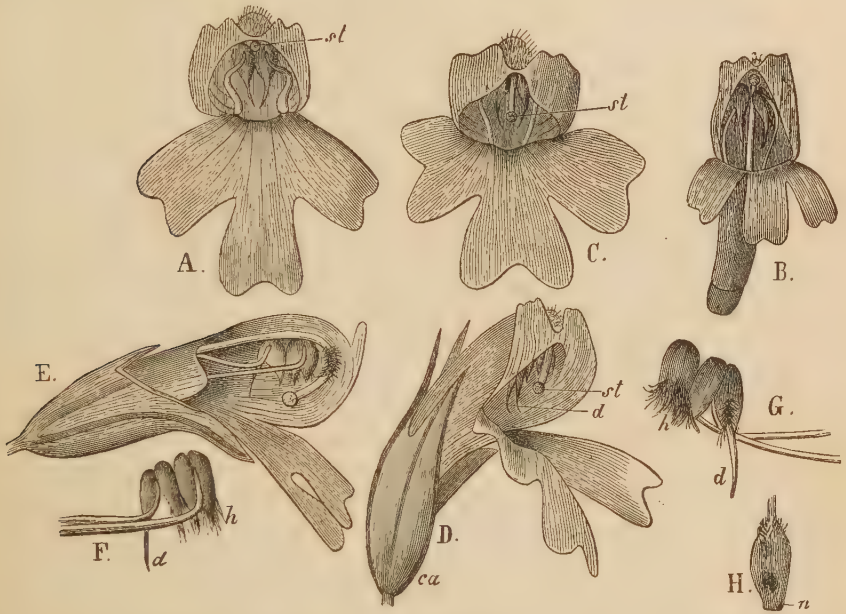


FIG. 321. *Euphrasia minima*, *Jacq.* (after Herm. Müller). *A.* Flower in the first stage, seen somewhat obliquely from in front and above. *B.* A smaller do., seen directly from the front. *C.* An older flower, with stigma bent under the upper anthers. *D.* Do., seen obliquely from the right front. *E.* Still older do., with stigma abundantly self-pollinated. *F.* The two right stamens, seen from outside, and more strongly magnified. *G.* Do., seen from inside. *H.* Ovary and nectary. (*A–E*, and *H* × 7.) *ca*, calyx; *d*, anther-process; *h*, hairs on anthers; *n*, nectary; *st*, stigma.

674. Trixago Stev.

2177. T. apula Stev. (= Bartsia Trixago *L.*). (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 353.)—In this Dalmatian species each anther possesses a downwardly-pointing process, which is pushed to one side by insects, thus opening the pollen receptacle and causing pollen to be sprinkled on the head and back of the visitors.

675. Lathraea L.

Protogynous bee flowers. Nectar (according to Stadler) secreted by a gland resembling a flattened bag, lying on the lower side of the ovary; it is stored at the base of the corolla-tube. Kerner says that the flowers are only entomophilous at first, becoming anemophilous towards the end of anthesis.

2178. L. squamaria L. (W. J. Behrens, 'Lehrbuch d. Botanik'; Knuth, 'D. Bestäubungseinricht. d. Orobancheen'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 330–1; Warnstorf, Schr. natw. Ver., Wernigerode, xi, 1896.)—The flowers,

of this species are developed in the ground, and the axis of the inflorescence is therefore bent round at its base, and the flower-buds are closely covered by the small bright-violet bracts, which overlap one another like tiles. Immediately after emerging from the earth, the inflorescence is still bent, but it straightens as the flowers become sexually mature, and is completely vertical only when the uppermost one has developed. Even then the unilateral inflorescence only projects a few cm. above the ground, and, as the plant is hidden beneath the leaves of associated species, it is not very conspicuous. It is, nevertheless, easily found by pollinating humble-bees, which, flying from plant to plant, work their way from bottom to top of each inflorescence. By following the humble-bee, other stocks of the plant are easily found. When the toothwort grows in an exposed situation, it is rather conspicuous, for the distichous bracts on the back of the inflorescence are red-violet in colour, with whitish margins. The front of the inflorescence, on the other hand, is rendered conspicuous by the closely-crowded flowers. Each of these possesses a violet calyx and a corolla with a red upper and a white lower lip. To this it must be added that the large yellow capitate stigma projects from the flower in the first stage of anthesis, and the hairy, whitish upper anthers in the second stage. The undivided upper lip serves as a kind of roof. The somewhat shorter, three-lobed lower lip lies close to the upper; a gutter is formed by each of its three divisions, the middle one being continued into the corolla-tube, and leading to the large, roundly-triangular, and somewhat lobed nectary situated at the base of the ovary. This gutter corresponds to a groove on the ovary and on the lower part of the style; this also reaches to the nectary, the abundant secretion of which collects as a drop in the angle between the gland and the ovary.

The filaments of the four stamens are still curled round during the first (female) stage, the anthers lying inside the lower lip, and not yet visible from outside. The stigma, on the contrary, projects from the upper lip almost before the flower opens. The stigma was yellow in the flowers I observed near Kiel, the flower mechanism of which I am describing, but according to Behrens it is red. At this stage cross-pollination must be effected by insect visitors, as the stigma can only be dusted with pollen from a flower in a later stage. The flowers are hermaphrodite for a short time in the transition stage which now follows, the stigma being still shining yellow and receptive, while the filaments have elongated and the dry pollen has been shed from the pollen-receptacle formed by the anther-lobes. This is so tightly closed by a thick growth of hairs, that the pollen cannot fall out until the short, blunt point of an anther receives a blow: this is given by humble-bee visitors, which are therefore sprinkled with the dusty pollen when they probe for nectar. During this transition to the second (male) stage, self-pollination becomes possible as the humble-bee creeps back, but it cannot be automatic. During the second (male) stage the style shrivels and the stigma becomes discoloured and dry. The corolla-tube, originally 3 mm. long, has grown to a length of 6 mm., and the upper and lower lips, which were at first 4 mm. and 5 mm. long respectively, have each gained one mm., while the style has not elongated, so that the stigma is covered by the upper lip. In consequence of the elongation of the filaments, the pollen-receptacle is now situated in the mouth of the flower, and is, as previously described, struck by humble-bee visitors and thus caused to scatter its pollen. Lateral dispersal is prevented by

the anther-hairs. The right way to the nectar is indicated by the nectar-groove on the corolla-tube and pistil already mentioned, and if this way is followed, not only contact with the stigma (in the first stage) but also with the anther-appendages (in the second stage) must take place. Another guide is provided by sharp projections covering the filaments below the anthers, so that any deviation from the proper direction would result in painful injuries to an insect's proboscis.

The humble-bee visitor first clings tightly to several flowers, then grasps the lower lip with its forelegs and pushes its head into the mouth of the flower, which is narrowed by the stamens to a slit about a mm. wide. In a flower with ripe anthers the visitor is sprinkled with pollen, and the part of its body thus dusted will touch the receptive stigma of the flowers in the second stage.

Kerner adds a third stage of anthesis. After the style and stigma have completely withered, the stamens continue to elongate, so that the anthers protrude from the flower. These, which have so far been bound together, now become separate, and the pollen, if it has not already been removed by insects, will be blown away in a little cloud by the wind. It is carried to the still receptive stigma of the upper flowers, and thus fertilizes them geitonogamously. Warnstorf describes the pollen-grains as white in colour, rounded ellipsoidal, and smooth, with three longitudinal grooves, on the average 46 μ long and 30 μ broad.

Visitors.—The following were recorded by the observers, and for the localities mentioned.—

Knuth (Kiel), the 3 commonest German humble-bees, all skg.—1. Bombus hortorum *L.* ♀; 2. B. terrester *L.* ♀; 3. B. lapidarius *L.* ♀. Höfmeyr (Bremen), the humble-bee Bombus agrorum *F.* ♀. Alfken (Bremen), an ant (Myrmica sp.). Stadler, 2 humble-bees—Bombus terrester *L.*, and B. muscorum *F.* ('Beiträge z. Kenntniss d. Nektarien').

676. Clandestina L.

2179. C. rectiflora Lam. (= Lathraea Squamaria *L.*, according to the *Index Kewensis*). (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 331.)—This species agrees to a large extent with Lathraea squamaria. It is indigenous to Belgium, West France, and South Europe. Loew ('Blütenbiol. Floristik,' pp. 302–3), who examined plants growing in the Berlin Botanic Garden, found them more feebly protogynous than those of Lathraea. The tubular calyx is about 19 mm., the galeate, violet upper lip of the corolla 22 mm., and the three-lobed, dark-brown-violet lower lip 13 mm. long. The style is bent down like a hook, and the stigma projects 4 mm. beyond the upper lip. In the first (female) stage the anthers are completely enclosed by the upper lip, and the stigma can only be cross-pollinated. In the second (male) stage the edges of the upper lip, hitherto closed to a narrow slit, expand, so that the now mature anthers are accessible. The latter always possess two acuminate hairy processes, and are held together in pairs by short tufts of hair. The ovary is laterally compressed and traversed by a longitudinal groove: the front of its base bears the three-lobed nectary. The way to the nectary is limited, during the first stage, to a deep groove down the middle of the inner surface of the lower lip. The stigma corresponds in position to the upper end of this, and must therefore be brushed against by visitors. In the second stage, the entrance is

opened so wide that a humble-bee in search of nectar can strike against the anther-processes, by which means the powdery pollen is showered down. Cross-pollination by insect-visits is therefore ensured.

LXXV. ORDER *OROBANCHACEAE* RICH.

677. Orobanche L.

Homogamous, more rarely protogynous bee flowers, sometimes with nectar secreted in their bases, sometimes entirely devoid of it.

2180. O. caryophyllacea Sm. (= O. Galii *Duby*). (Kirchner, 'Flora v. Stuttgart,' pp. 642–3.)—The nectar-yielding flowers of this species possess a clove-like (Kirchner) or benzoloid (Kerner) odour. The corolla-tube is somewhat bent, and widens out gradually from base to mouth. The lower lip is trilobed, and provided with four folds at each side of the middle lobe, inclining inwards against the upper lip. These folds narrow the entrance of the flower to such an extent that a bee visitor, in pushing its head below the upper lip, must touch stigma and anthers. The flowers are homogamous. The large, feebly bilobed stigma projects beyond the anthers, so that it must be first touched by an insect, the next flower visited being therefore cross-pollinated. The four anthers are laterally united, and each lobe is provided with a sharp, stiff, downwardly-directed process. These processes are behind the stigma, and if anything strikes against them the bright-yellow, powdery pollen falls out of the anther-lobes, and is sprinkled on the proboscis or head of the visitor. Automatic self-pollination is excluded.

2181. O. Rapum-genistae Thuill.; **2182. O. lutea** Baumg. (= O. rubens *Wallr.*); **2183. O. alba** Steph. (= O. Epithymum *DC.*); **2184. O. gracilis** Sm. (=O. cruenta *Bertol.*). (Schulz, 'Beiträge,' II, p. 219.)—Schulz noticed perforated flowers of these species at Siegen in Westphalia, at Halle, and at Bozen and Oberbozen (Tyrol). In the last-named species the perforations were made by Bombus terrester *L.*

2185. O. major L. (= O. elatior *Sutton*). (Knuth, 'D. Bestäubungseinricht. d. Orobancheen.')—So far as mechanism goes the flowers of this species belong to class **Hb**, but those I observed at Heiligenhafen in Land Oldenburg were without scent or nectar, and of an inconspicuous brown colour. The stigma at first projects beyond the anthers, but is afterwards reached by them, so that automatic self-pollination must take place.

2186. O. crenata Forsk. (= O. speciosa *DC.*). (Knuth, 'Blütenbiol. Herbstbeob.')—This species is indigenous to France and Italy. I was able to study it in the Kiel Botanic Garden, where it was growing as a root-parasite on Vicia Faba *L.* The large bilobed stigma is situated above the entrance to the curved corolla-tube (2 cm. long), and the four anthers lie behind it in the tube, so that automatic self-pollination is excluded. When one of the larger insects creeps into the flower, it first touches the stigma, and then strikes against the downwardly-directed anther-processes. The first visited flower is self-pollinated as the insect backs out of it, but those subsequently visited will be crossed.

Visitors.—I observed the honey-bee. Before creeping into the corolla, it first examined a number of flowers from outside, flying from one to another and hovering for some time like a Syrphid in front of the flower-entrance without touching it. Using the large lower lip as a platform, it then crept far into the flower, touching, as previously described, first the stigma and then the anthers. It soon emerged, however, and repeated its attempts to obtain nectar from a number of other flowers, thus effecting cross-pollination. As a matter of fact, this species of Orobanche does secrete a certain amount of nectar at the orange-yellow base of the ovary.

2187. O. ramosa L. (=Phelypaea ramosa *C. A. Mey.*). (Knuth, 'Blütenbiol. Herbstbeob.'; Kirchner, 'Flora v. Stuttgart,' p. 644; Warnstorf, Verh. bot. Ver., Berlin, xxxvii, 1896.)—The flower mechanism of this species, which I was able to observe as a root-parasite on hemp in the Kiel Botanic Garden, is the same as that of the preceding species, but the corolla-tube is only 12 mm. long. Kirchner and Warnstorf describe the odourless flowers as feebly protogynous. The trilobed lower lip possesses shallower grooves than those of O. caryophyllacea. The mouth of the flower is 3–4 mm. broad and $2\frac{1}{2}$–3 mm. high, but can become considerably wider by the straightening out of its folds. The stigma projects beyond the free anthers, which lie in two rows, each ending in two sharp processes. Cross-pollination is therefore favoured at first, but insect-visits have not yet been observed. Automatic self-pollination is rendered possible by the bending down of the front end of the style, the stigma thus coming into contact with the pollen of the two anterior anthers. Warnstorf describes the pollen-grains as small, white in colour, ellipsoidal, delicately tuberculate, about 30 μ long and 16–19 μ broad.

2188. O. purpurea Jacq. (=O. caerulea *Vill.*, and Phelypaea caerulea *C. A. Mey.*). (Knuth, 'Bestäubungseinricht. d. Orobancheen.')—I saw this plant on the north shore of the Eckernförde as a root-parasite on Achillea millefolium, but in spite of the conspicuousness of its large blue racemes, observed no insect-visits. The flowers are odourless and nectarless, but their mechanism places them in class **Hb**. At first the stigma projects beyond the anthers, but these soon reach the same level, so that automatic self-pollination is effected.

678. Cistanche Hoffmgg. et Link.

2189. C. lutea Hoffmgg. et Link (=Phelypaea lutea *Desf.*). (Trabut, Bul. soc. bot., Paris, xxxiii, 1886, pp. 536–9.)—Trabut observed plants of this species in Oran, a province of Algeria. They bore subterranean cleistogamous flowers with closed tubular corollas.

LXXVI. ORDER *LENTIBULARIACEAE* RICH.

679. Utricularia L.

Yellow, herkogamous flowers, with sensitive stigmas; belonging to classes **Fh** and **Hb** (?). The lower lip is so close to the upper that the entrance to the flower is closed. The former serves as an alighting-platform for insects, by the weight of which it is depressed: it bears a nectar-yielding spur. The upper lip forms a shelter for anthers and stigma. The latter is sensitive, and bends upwards and backwards after having been touched by an insect.

2190. U. vulgaris L. (Buchenau, Bot. Ztg., Leipzig, xxiii, 1865, pp. 93 et seq.; Hildebrand, op. cit., xxvii, 1869, pp. 505–7; Heinsius, Bot. Jaarb. Dodonaea, Ghent, iv, 1892, pp. 78–9; MacLeod, op. cit., v, 1893, pp. 359–60; Kirchner, 'Flora v. Stuttgart,' pp. 640–1; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 356.)—In this species the corolla is of a yolk-yellow colour, and orange-yellow streaks on the palate serve as nectar-guides. The lower lip bears the large, thick spur, which is at an angle of 75° to its long axis. On being visited by an insect, the lower lip is so far depressed that the spur points vertically downwards. A bee probing for the nectar secreted by and concealed in the spur brings its head and back into contact with the stigma and the two anthers lying just under the upper lip. The latter are borne on broad, curved filaments, and lie close together. The ovary is situated just behind them, touching the inner surface of the upper lip, the style projecting beyond the stamens, so that an insect visitor touches the stigma first, and, if it brings

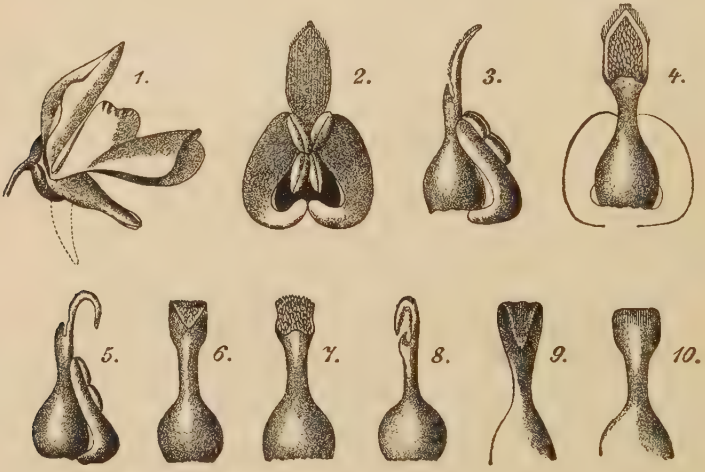


FIG. 322. *Utricularia vulgaris*, *L.* (after Hildebrand). (1) Flower, seen from the side: the dotted outline indicates the position assumed by the spur when the lower lip is pressed down (natural size). (2) Stamens and pistil shortly before the flower opens, seen from below. (3) Do., seen from the side. (4) Do., seen from above. (5) Do., from a just opened flower, seen from the side: the lower stigmatic lobe has bent down. (6) Do. (without the stamens), seen from below. (7) Do., seen from above. (8)–(10) The pistil, from the side, above, and below, showing how the lower stigmatic lobe, when not hampered by the corolla, bends round strongly upwards after being stimulated.

pollen from another flower, pollinates it. The stigma consists of two lobes, a short, tooth-like upper one, resting against the upper lip, and a long tongue-shaped lower one, covered with stigmatic papillae on its upper surface.

As soon as the flower has opened, the anthers dehisce, and the tongue-shaped lobe of the stigma bends downwards, exposing its papillated surface to visitors, which dust it with pollen. The contact serves as a stimulus, causing the lobe to fold upwards and backwards so far that the stigmatic surface is concealed. This prevents autogamy as the insect backs out of the flower. Automatic self-pollination is excluded or is ineffective, for the flowers seldom form seeds. Kerner states that if insect-visits fail, the edge of the stigma comes into contact with the anthers and autogamy is thus effected.

Heinsius says that the stigma is blunt and beset on the upper margin with stiff hairs, which act as combs to draw the pollen-grains out of the visitors' hairs when the lobe folds up. These grains then adhere to the upwardly-directed stigmatic papillae. It is particularly easy for the pollen-grains to be combed out of the insects' hairs, for they are provided with numerous meridional furrows, making them easy to seize.

A complicated flower mechanism such as that described can as a rule only be operated by bees. Heinsius, however, has also noticed hover-flies. They alight on the lower lip and push against the upper one until the former is pressed down and the entrance to the nectar exposed. They suck for some seconds, and then go to another flower of the same species. Helophilus lineatus *F.* (in large numbers) and Rhingia campestris *Mg.* (occasionally) behave in this way. Heinsius deduces from his observations that long-tongued hover-flies are the normal pollinators, and thinks that, the mouth of the flower being too narrow for most bees, there can be no question of visits from them. He adds—'It may be seen from this, that the hover-flies mentioned have reached such a high stage of mental development that they can find the way into a completely closed flower.'

Visitors.—*Vide supra.*

2191. U. major Schmedel (=U. neglecta *Lehm.*).—Buchenau says that the mechanism of this species agrees with that of the preceding one.

2192. U. minor L. (=U. Bremii *Heer*).—Buchenau describes this species as possessing a small, blunt, conical spur projecting at right angles to the axis of the flower. And *vide* next species.

2193. U. ochroleuca R. Hartm. (Abromeit, 'Bot. Ergeb. v. Drygalski's Grönlandsexped.,' pp. 41–2.)—Vanhöffen only observed sterile plants of this species in Greenland, as did Hartz, Berlin, and Kolderup-Rosenvinge in the case of U. minor *L.*

680. Pinguicula Tourn.

Flowers, blue or white, homogamous or protogynous, without a sensitive stigma, and belonging to class **Hb** or **Fpt.** The lower lip serves as an alighting-platform. The spur either secretes and conceals nectar in its base, or contains small, stalked, capitate projections serving as food.

2194. P. vulgaris L. (Sprengel, 'Entd. Geh.,' pp. 54–6; Warming, 'Arkt. Växt. Biol.,' pp. 31 et seq.; Axell, 'Om Anord. för Fanerog. Växt. Befrukt.,' pp. 42–3; Hildebrand, Bot. Ztg., Leipzig, xxvii, 1869; Herm. Müller, 'Alpenblumen,' pp. 354–5.)—The flowers of this species belong to class **Hb.** They are horizontal, and of a deep blue colour. Nectar is secreted at the base of the long, thin, downwardly-curved spur. The stigma lies below the bifid upper lip, and its large lobes cover the anthers, which are immediately beneath it. The whole flower mechanism, therefore, agrees with that of Utricularia, except that the stigma-lobes are not sensitive. When a bee of the right size visits the flower, it touches first the papillose lower stigma-lobe and dusts it with pollen should another flower have been previously visited. On penetrating further into the flower, the bee's head and back are dusted with fresh pollen: this, however, is not deposited on the stigma of the same flower when the bee creeps back, because in doing so it forces the papillose stigmatic lobe upwards. Insect-visits, therefore, ensure cross-pollination in this case,

and self-pollination is excluded. Kerner, however, asserts that the latter may take place automatically, as also in Utricularia.

Buchenau always observed abundant seed-formation, but says that autogamy is excluded, as the lower stigma-lobe covers the anthers. Warming follows Kerner in believing that, as the stigma-lobe rolls up, it finally comes into contact with the anthers, by which means automatic self-pollination does at last take place.

Lindman observed flowers on the Dovrefjeld which were almost cleistogamous.

Plants observed in Greenland resembled the typical European form. The corolla was 10–15 mm. long, and the narrow spur 5–7 mm. Winter-buds are developed early, and in 1892 Vanhöffen found them on July 11 (Abromeit, 'Bot. Ergeb. v. Drygalski's Grönlandsexped.,' p. 41).

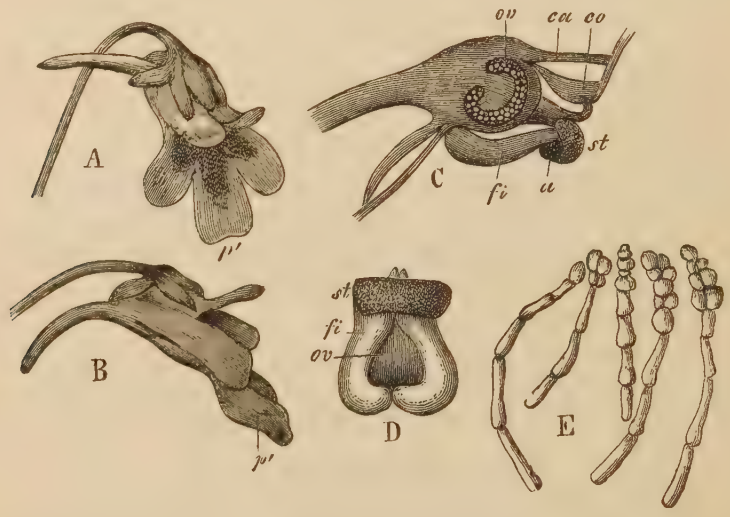


FIG. 323. *Pinguicula vulgaris*, *L.* (after Herm. Müller). *A.* Flower seen obliquely from above (× 2). *B.* Do., seen from the side. *C.* Reproductive organs in longitudinal section (× 7). *D.* Do., of another flower, seen from below. *E.* Hairs from the lower side of the inner surface of the corolla. *a*, anther; *ca*, calyx; *co*, corolla; *fi*, filaments; *ov*, ovary; *p'*, central lobe of lower lip; *st*, stigma.

VISITORS.—The following were observed by Herm. Müller in the Alps.—

The bee Osmia caementaria *Gerst.* ♂, skg.; adapted to the flowers by its size of body and length of proboscis. A Lepidopterid and 2 beetles as unbidden guests.

2195. P. grandiflora Lam. MacLeod (Pyrenees) did not observe effective pollinators, but frequently saw the beetle Anthobium atrum *Heer* in the spur.

2196. P. alpina L. (Hildebrand, Bot. Ztg., Leipzig, xxvii, 1869; Warming, 'Arkt. Växt. Biol.,' pp. 31 et seq.; Herm. Müller, 'Alpenblumen,' pp. 352–4.)—This species bears pinch-trap flowers, the mechanism of which has already been described and figured in Vol. I, pp. 132–3.

VISITORS.—Herm. Müller (Alps) saw 15 flies, 5 bees, 3 Lepidoptera, and the beetle Meligethes.

2197. P. lusitanica L.—Henslow says that the flowers of this species are self-fertilized.

2198. P. villosa L. (Warming, 'Arkt. Växt. Biol.,' pp. 27–31.)—This species bears flowers possibly belonging to class **L.** Warming, who examined their mechanism at Besekop, states that they are rather small, with a very narrow spur and entrance, so that only the thin proboscis of a Lepidopterid can penetrate to their interior. The front margin of the anterior stigma-lobe touches the pollen of the anthers, which ripen at the same time, and automatic self-pollination is therefore inevitable. Warming also frequently observed that pollen-tubes had penetrated into the stigma.

LXXVII. ORDER *ESNERIACEAE* ENDL.

LITERATURE.—Fritsch, 'Gesneriaceae,' in Engler and Prantl's 'D. nat. Pflanzenfam.,' IV, 36; Delpino, 'Sugli appar. d. fecondaz. nelle piante autocarp.'; Ogle, Pop. Sci. Rev., London, ix, 1870, pp. 51–2.

Fritsch says that the unusual brilliance of colouring exhibited by many flowers of this order (showing, for example, every possible shade of vivid red), together with their zygomorphy, points to the conclusion that they are entomophilous, and many, perhaps, pollinated by humming-birds. They are strongly protandrous.

681. Episcia Mart.

2199. E. maculata.—Oliver says that the throat of protandrous flowers of this species (growing in Kew Gardens) is firmly closed. Autogamy is excluded by the position of anthers and stigma, and a bee with a very long proboscis probably brings about pollination by opening the valvular flower. Artificial fertilization was effective. Extra-floral nectaries keep away ants.

LXXVIII. ORDER *BIGNONIACEAE* R. BR.

682. Catalpa.

Kerner says that the species of this genus possess bilobed sensitive stigmas like those of Mimulus.

683. Bignonia L.

Delpino ('Ult. oss.,' p. 149) says that in species of this genus the flowers are protandrous, with stamens and style which move in opposite directions. Self-pollination is excluded, because the stigma-lobes close before pollen from the same flower can be transferred to them.

684. Martynia Houst.

As Bignonia (Delpino, 'Sugli appar. d. fecondaz. nelle piante autocarp.,' pp. 32–3; Hildebrand, Bot. Ztg., Leipzig, xxv, 1867, p. 284).

LXXIX. ORDER *ACANTHACEAE* R. BR.

Flowers protogynous, nectar-yielding, usually brightly coloured, and often united into large inflorescences, being thus adapted to attract visitors.

G. Beck von Mannagetta ('Orobanchaceae,' in Engler and Prantl's 'D. nat. Pflanzenfam.,' IV, 36, p. 127) says that insect visitors cause the pollen to be emptied

on their backs by striking against the downwardly directed points of the pollen-receptacle. They transfer this to the curved, projecting stigma of another flower. Premature dispersal of pollen is prevented by the hairs which frequently surround the anther-processes.

685. Acanthus Tourn.

Literature.—E. E. Haare, Natur und Haus, vi, pp. 183–4.

Protandrous humble-bee flowers, with the reduced upper lip replaced by the upper sepal, which covers the entire flower. Loew states that the nectary, situated at the base of the ovary, sheds its secretion into a protrusion at the bottom of the flower, which serves as a nectar receptacle, and is protected by hairs.

2200. A. spinosus L. (Delpino, 'Ult. oss.,' p. 33; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 273; Knuth, 'Bloemenbiol. Bijdragen.')—In the flowers of this species a convenient alighting-platform is formed by the large, trilobed lower lip; this is supported by the posterior sepal, which resembles an upper lip. The filaments are strong, curved rods, that can only be separated by large and powerful humble-bees. When this takes place, the pollen receptacle is opened, and the bees are sprinkled with pollen. Each anther possesses a single loculus, resembling a long, narrow niche, each side of which is fringed with hairs. The pollen receptacle is thus kept firmly closed. The style at first lies close to the roof of the flower, but bends downwards later on, bringing the stigma into the direct line of approach to the nectar.

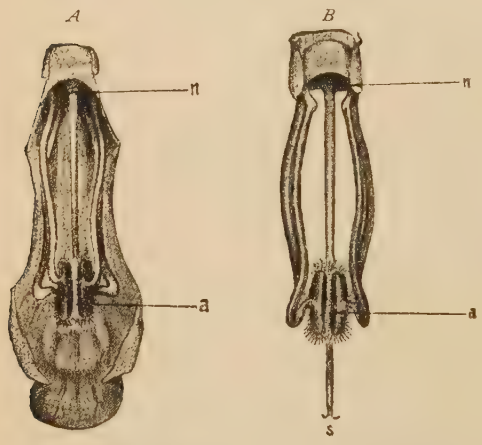


Fig. 324. *Acanthus spinosus*, L. (from nature). *A*. Flower in the first (male) stage, seen from above after removal of the upper protective sepal and the reduced upper lip. *B*. Do., in the second (hermaphrodite) stage, seen from below after removal of the lower lip. *a*, anthers; *n*, nectary; *s*, stigma.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel Botanic Garden), 2 humble-bees (Bombus terrester *L.* ♀, and B. hortorum *L.* ♀), which crept under the sepal functioning as an upper lip, and remained skg. nectar for some time; also the earwig Forficula auricularia *L.*, dvg. the flowers. Delpino, 2 humble-bees—Bombus italicus *F.*, and B. terrester *L.*

2201. A. mollis L., and **2202. A. longifolius** Poir.—Kerner states that the flower mechanism of these two species agrees with that of A. spinosus.

Visitors.—Delpino observed the same 2 humble-bees as for A. spinosus.

686. Ruellia Plum.

2203. R. tuberosa L. (= Cryphiacanthus barbadensis *Nees*).—Dillenius pointed out that this species bears cleistogamous flowers (von Mohl, Bot. Ztg., Leipzig, xxi, 1863, p. 310).

687. Aechmanthera Nees; 688. Doedalacanthus Anders; 689. Eranthemum L.

Species of these genera sometimes bear cleistogamous flowers.

690. Aphelandra R. Br.

2204. A. cristata R. Br. (Delpino, 'Ult. oss.,' pp. 231–2.)—In the flowers of this species two of the four corolla-lobes surround the anthers, the remaining two forming a door closing the entrance. When this is opened the upper corolla-lobes separate, so that the anthers are freed, and scatter pollen on visitors.

Visitors.—Delpino supposes that these are humming-birds.

691. Rhinacanthus Nees.

2205. R. communis Nees. (Delpino, 'Altri appar. dicog. recent. oss.')—In the markedly protandrous flowers of this species the anthers of both stamens, which bend down into the mouth of the flower, dehisce during the first stage of anthesis, while the still immature stigma is bent upwards. In the second stage the stigma is mature and stands in the way of the visitor's proboscis, while the stamens are bent towards the sides.

Visitors.—Delpino supposes that these are Lepidoptera.

692. Thunbergia Retz.

2206. T. alata Boj. (Hildebrand, Bot. Ztg., Leipzig, xxv, 1867, p. 285.)—When an insect pushes its way into the flowers of this species, it brushes with its back first the stigma and then the anther-processes, so that it is covered with pollen, which it transfers to the stigma of another flower.

2207. T. erecta T. Anders (= Meyenia erecta *Benth.*).—This species is indigenous to West Africa. Its flowers grow almost horizontally. The bilobed stigma is situated in the mouth of the flower; only its upper part is receptive, and it is rolled up into a tube. On being visited by an insect, the lower part of the stigma, which stands directly in its way, is pressed so far down that the receptive upper portion reaches the insect's back, and, if this is already covered with pollen, takes up some of it. If the insect pushes further into the flower, it is dusted anew, for the anthers are situated in the middle of the corolla-tube and are provided with hairs, which catch the falling pollen. When the visitor creeps out of the flower, the lower part of the stigma prevents the upper from being self-pollinated.

693. Strobilanthus Blume.

2208. S. anisophyllus T. Anders (= Goldfussia anisophylla *Nees*). (Morren, Nouv. Mém. Acad. roy., Bruxelles, vi, 1831, xii, 1839.)—In this species also the flowers are almost horizontal. Only the lower side of the stigma is receptive, and

the style being bent upwards the visitor first comes into contact with the stigmatic papillae. Later on the style straightens out, so that it applies itself to the under-side of the corolla. On creeping further into the flower, the insect is covered with fresh pollen, which it can no longer transfer to the stigma of the same flower. Morren, nevertheless, considered the flower mechanism self-pollinating, because he thought that the pollen falling on the corolla could reach the stigma.

694. Jacobinia Moric.

2209. J. pohliana Benth. (= Cyrtanthera pohliana *Nees*).—Stadler describes the flowers of this species as feebly protandrous.

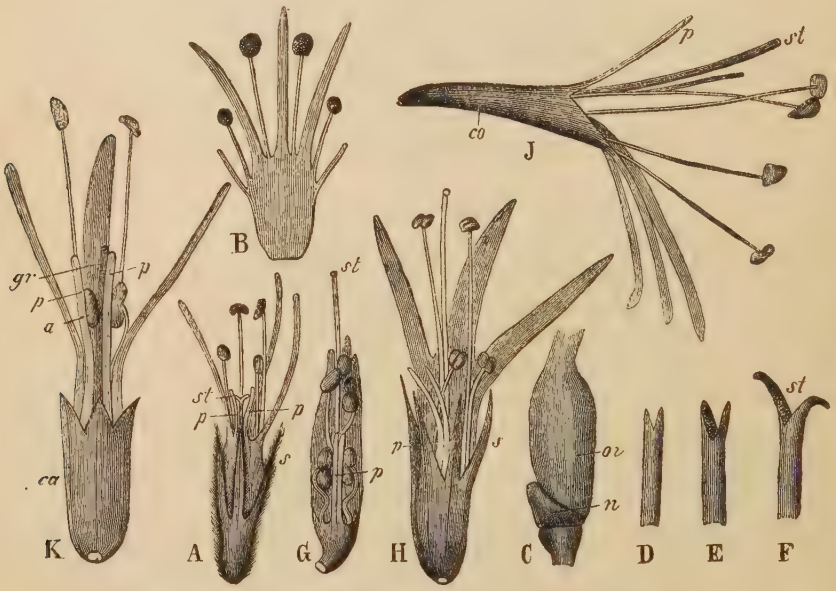


FIG. 325. *Globularia*, *Tourn.* (after Herm. Müller). *A–F. Globularia vulgaris*, *L.* *A.* Flower of which all four anthers have dehisced, seen from above. *B.* Corolla of do., flattened out (× 7). *C.* Ovary and nectary. *D.* End of the style from a flower in which the longer stamens have dehisced. *E*, *F.* Further development of do., after dehiscence of all four stamens (× 35). *G–J. Globularia cordifolia*, *L.* *G.* Bud, after removal of calyx, seen from above. *H.* Flower seen from above. *J.* Older do., after removal of the calyx, seen from the side (× 7). *K. Globularia nudicaulis*, *L.* Flower seen from above (× 7). *a*, anthers; *ca*, calyx; *co*, corolla-tube; *gr*, style; *n*, nectary; *ov*, ovary; *p*, upper lobes of corolla; *s*, calyx-teeth; *st*, stigma.

LXXX. ORDER *SELAGINEAE* DC.

695. Globularia Tourn.

Blue Lepidopterid flowers. Numerous florets are aggregated into a rounded head. They secrete nectar from the fleshy base of the ovary and store it in the corolla-tube, this being, however, so narrow that the nectar is only accessible to the thin proboscis of Lepidoptera. Each corolla-tube is divided into five linear lobes, two shorter upper and three longer lower ones. Between these two shorter upper and two longer lower stamens are placed. When these diverge and are widely

exserted from the corolla-tube, nectar-sucking Lepidoptera must brush stigma and anthers with their proboscis or head, thus bringing about cross-pollination. This can also be effected by pollen-collecting bees or pollen-devouring flies, but only Lepidoptera succeed in reaching the nectar.

2210. G. vulgaris L. (Herm. Müller, 'Alpenblumen,' pp. 327–8.)—This species is protandrous, and if visited by insects the pollen is removed before the stigma matures, thus rendering cross-pollination inevitable. Should such visits fail, automatic self-pollination is easily effected, pollen falling from higher flowers on to the stigmas of lower ones.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller, a Lepidopterid, 2 bees, and the beetle Meligethes. Schletterer and von Dalla Torre (Tyrol), the bee Prosopis hyalinata *Sm.*

2211. G. cordifolia L. (Ricca, Atti Soc. ital. sc. nat., Milano, xiii, 1870; Herm. Müller, 'Alpenblumen,' p. 328; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. I, II, pp. 91–2, 123–4.)—The flowers of this species are protogynous with a persistent stigma. The style with mature stigma projects (while the flower is still young) beyond the unripe anthers. When the latter dehisce, the filaments elongate to such an extent that they equal, or even exceed the style in length. Hence cross-pollination by insect-visits is ensured during the first stage of anthesis, while in the second self-pollination is possible. Kerner says that the anthers close up in damp weather, thus protecting the pollen from wet.

Visitors.—Herm. Müller observed 5 Lepidoptera, 2 bees, and a fly.

2212. G. nudicaulis L. (Herm. Müller, 'Alpenblumen,' pp. 328–9.)—This species is protogynous with a persistent stigma, and agrees in all other respects with G. vulgaris.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 4 Lepidoptera, a small bee, and a hover-fly. MacLeod (Pyrenees), 2 bees (Halictus sp.), 2 Lepidoptera, a hover-fly, and 2 Muscids (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 323).

LXXXI. ORDER *VERBENACEAE* JUSS.

The only genus of this order found in Central and South Europe, and in North America, is—

696. Verbena L.

Homogamous bee flowers; with nectar secreted by the base of the ovary and stored at the bottom of the short corolla-tube. Protection against unbidden guests is afforded by a ring of hairs which firmly closes up the corolla-tube.

2213. V. officinalis L. (Sprengel, 'Entd. Geh.,' p. 57; Herm. Müller, 'Weit. Beob.,' III, pp. 42–4, 'Alpenblumen,' p. 307; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 362–3; Kirchner, 'Flora v. Stuttgart,' p. 645; Knuth, 'Blütenbiol. Herbstbeob.')—The small, pale-violet flowers of this species are aggregated in long, loose paniculate spikes. The corolla-tube is 3–4 mm. long; its

lower, nectar-bearing part is directed obliquely upwards, while its upper part is horizontal. This curve not only protects anthers, stigma, and nectar from rain, but also affords a bee's proboscis the most convenient position for sucking. The limb of the corolla consists of a surface 3 mm. high and 4 mm. broad, divided into five lobes. The lowest of these forms an alighting-platform, and gives standing-room to small, nectar-seeking bees. Four rows of bristles, directed obliquely outwards, oblige the visitor to insert its proboscis into the space between them. When thus inserted, it first brushes against the anthers (which are covered by a circlet of hairs) and then the stigma, but is not dusted with pollen, or only very slightly so, for the dehisced surfaces of the anthers are directed obliquely downwards towards the base of the flower, so that the proboscis must twist these surfaces a little further back. In consequence of the narrowness of the corolla, the insect, in creeping back, presses the anthers in the opposite direction, and their dehisced surfaces touch and dust its proboscis, the end of which is wet with nectar, so that pollen easily adheres. On visiting another flower, the bee brushes some of this off on to the stigma, which is situated behind the anthers in the corolla-tube, and its proboscis is dusted anew on being withdrawn. Insect-visits therefore generally effect cross-pollination. The two lower of the four anthers, however, lie so close to the stigma that some of their pollen easily reaches it, bringing about automatic self-pollination (which is effective) should these visits fail. Besides flowers with properly developed, ripe anthers, there are others in which only two anthers are fertile. If the two longer stamens are reduced, self-pollination is of course favoured, and if the two shorter ones, only cross-pollination is possible.

Visitors.—Burkill and Willis observed the following at Cambridge ('Flowers and Insects in Great Britain,' Part I).—

A. Diptera. *Syrphidae*: 1. Platycheirus sp., skg.; 2. Syrphus sp., skg. **B. Hymenoptera.** *Apidae*: 3. Apis mellifica *L.*, freq., skg.; 4. Bombus agrorum *F.*, do. **C. Lepidoptera.** *Rhopalocera*: 5. Lycaena icarus *Rott*, freq., skg.

The following were recorded by the observers, and for the localities stated.—

Buddeberg (Nassau), 4 bees, skg.—1. Halictus flavipes *K.* ♂; 2. H. lugubris *K.* ♂; 3. H. nitidus *Schenck* ♀; 4. H. quadricinctus *K.* ♀. Knuth (Kiel), the humble-bee Bombus pratorum *L.*, skg., and 2 hover-flies, skg.—Eristalis sp., and Syritta pipiens *L.* Herm. Müller (Alps), the honey-bee, a humble-bee (Bombus sp.), and a butterfly (Epinephele sp.). Schenck (Nassau), the bee Halictus pauxillus *Schenck.* Schletterer (Pola), 2 bees—Anthidium strigatum *Pz.*, and Ceratina cucurbitina *Rossi.* Alfken (Aquileja), 4 bees—1. Ceratina cucurbitina *Rossi.* ♀ and ♂, skg.; 2. C. cyanea *K.* ♀ and ♂, skg.; 3. Halictus morio *F.* ♀ and ♂; 4. H. virescens *Lep.* ♀, very common, skg. and po-cltg., ♂, rare, skg. MacLeod (Pyrenees), 5 humble-bees, 5 sp. of Halictus, 3 butterflies, 3 hover-flies, and a Bombyliid (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 323–4). Loew (Berlin Botanic Garden), 2 bees—Apis mellifica *L.* ☿, skg., and Halictus cylindricus *F.* ♂, do.

2214. V. hastata L. × **V. officinalis** L.—

Visitors.—Loew (Berlin Botanic Garden) observed 2 bees, skg.—Apis mellifica *L.* ☿, and Halictus sexnotatus *K.* ♀.

2215. V. urticifolia L.—

Visitors.—Loew (Berlin Botanic Garden) observed the humble-bee Bombus terrester *L.* ☿, skg.

697. Aegiphila Jacq.

2216. A. elata Sw., and **2217. A. mollis** Jacq.—Darwin describes these species as dimorphous ('Different Forms of Flowers').

2218. A. obducta.—Darwin (J. Linn. Soc. Bot., London, vi, 1862) describes this species as dioecious.

LXXXII. ORDER *LABIATAE* JUSS.

Literature.—Sprengel, 'Entd. Geh.,' pp. 303–4; Herm. Müller, 'Fertilisation,' pp. 469–503; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins., p. 116, 'Grundriss d. Blütenbiol.,' p. 83; Briquet, 'Labiatae,' in Engler u. Prantl's 'D. nat. Pflanzenfam.,' IV, 3 a, pp. 200, 201, 202, 225–72, 273–320, 321–80.

The inflorescences are usually very conspicuous, and attract numerous insects, which, as Hermann Müller points out, belong to very varied groups. The kind of visitor depends on the length of the corolla-tube, at the bottom of which the nectar secreted at the base of the ovary is concealed. The short-tubed flowers of Mentha and Lycopus are mostly visited by flies; in the case of Thymus and Origanum not only these but also bees in increasingly large numbers are to be found; in Betonica flies and bees play an almost equally important part; Stachys palustris *L.* and S. sylvatica *L.* are visited by bees in a decided majority; and, finally, Lavandula, Salvia, Lamium, Galeopsis, Ballota, Teucrium, and Ajuga are pollinated almost exclusively by bees, the only exceptions being in the case of some Lepidoptera and Diptera with the most elongated mouth-parts. The last-named group belong therefore to flower-class **H**, the first-named to **C**. Scutellaria, and also Teucrium pyrenaicum *L.*, possess a Lepidopterid door as well as one for humble-bees, belonging therefore to **Hh** and **Lb**. The lower lip serves as a convenient alighting-platform, while the upper one holds the anthers and stigma in certain relative positions, and at the same time forms a protective roof for the stamens. If this upper lip should be absent, it is frequently replaced by bracts projecting beyond the flower. The corolla-tube is often so much bent that its curve corresponds to that of a humble-bee's proboscis. In many cases automatic self-pollination is completely or partially prevented by dichogamy; in homogamous flowers it is entirely or temporarily hindered by the relative positions of stamens and pistil.

Briquet distinguishes two oecological flower types. In the first, the butterfly type, the anterior part of the corolla is produced in front, and the stamens and style are situated on the lower lip. The secretion of nectar sometimes takes place in the upper-side of the flower, and pollen is then scattered on the legs and under-sides of insects. There are four varieties of this type:—(1) The Ocimoideae are constructed entirely according to the described plan. They are to a large extent protandrous bee and humble-bee flowers. (2) The flowers are resupinate by torsion of the pedicel, so that the positions of the upper lip and the reproductive organs are reversed (e. g. Lophanthus chinensis *Benth.*). (3) Resupination results from torsion of the corolla-tube (Ajuga orientalis *L.*, Teucrium spinosum *L.*, T. resupinatum *Desf.*, and all species of Satureia belonging to the group Cyclotrichium).

(4) The flowers are pendulous, so that the upper lip is directed point downwards and functions as a lower lip (Salvia nutans *L.*). The second type includes the typical labiate flowers, in which the upper lip forms a roof for the stamens and pistil. In these species nectar is always secreted on the lower side of the flower, and pollen is scattered on the insect's back.

Many South American species (Salvia gesneraeflora *Lindl. et Paxt.*, and S. splendens *Ker-Gawl.*) are ornithophilous. Besides hermaphrodite flowers, female ones are frequently present, distributed gynomonoeciously or more rarely gynodioeciously. Gynodioecism is not infrequent in England; e.g. F. Darwin, and subsequently J. C. Willis (Proc. Phil. Soc., Cambridge, vii, 1892, viii, 1893), often found flowers of Origanum vulgare *L.* with reduced stamens. He also observed gynodioecism in Thymus Serpyllum *L.*, Nepeta Glechoma *Benth.*, N. Cataria *L.*, Prunella vulgaris *L.*, and in the following garden plants: Micromeria juliana *Benth.*, Nepeta longiflora *Vent.*, Hyptis pectinata *Poit.*, Bystropogon punctatus *L'Hérit.*, Mentha aquatica *L.*, Satureia hortensis *L.*, and S. montana *L.*

Schulz sums up his investigations ('Beiträge,' II, pp. 138–41) somewhat as follows.—

The size of the hermaphrodite flowers in most labiates varies greatly in the same station, and in some species even on the same plant. Several, generally two, definite sizes are to be seen in many districts in the flowers of some species: these are either entirely distinct or connected by an occasional transition form. In other districts only one of these sizes is to be found, while in some places it becomes impossible, on account of the great number of transition forms, to distinguish definite flower-sizes at all. The hermaphrodite flowers of most of the species treated by Schulz are more or less protandrous, but a few, such as Stachys annua *L.* and Galeopsis ochroleuca *Lam.*, always bear completely homogamous flowers. Some species, e.g. Salvia pratensis *L.*, Prunella grandiflora *Jacq.*, P. vulgaris *L.*, and Ajuga reptans *L.*, vary between feeble protandry and homogamy; indeed, in the case of the first-named species, this often occurs in flowers on the same plant. Automatic self-pollination always takes place in some of the few species with homogamous or feebly protandrous flowers, but is rendered very difficult in others by the unfavourable relative positions of the stigma and anthers. In markedly zygomorphous flowers the stamens are almost in the same plane, and lie near or quite close to the upper lip, or are at least just in front of it. The anthers are introrse, and dehisce in descending order on each side of the median plane, i.e. they turn their pollen-covered surfaces towards the lower lip. In flowers of practically actinomorphous type, e.g. those belonging to the genus Mentha, the stamens are not crowded together into nearly the same plane in front of the upper lip, but are disposed according to their insertions in front of the calyx-teeth. The anthers are attached by conveniently flexible insertions to the filaments, and are almost horizontal, being so placed that they turn their tips to the margin of the flower, and become covered above with pollen. Towards the end of dehiscence, or after its completion, they usually become curved, and their two ends project slightly downwards. The larger insect visitors strike in both types, almost without exception, against the pollen-covered surfaces of the anthers; in certain species of Salvia, however, a special lever-like mechanism is necessary for pollination, on account of the breadth of the mouth of the corolla

This forms a barrier at the mouth of the flower, and must therefore be struck against and pressed back by an insect visitor.

Female flowers occur in many species. These usually grow on separate stocks, much more rarely (and in some species exceedingly so) they are associated with hermaphrodite flowers on the same plant, and as a rule on the same inflorescence. In the latter case either each kind of flower has a special position or both forms are arranged anyhow. In many species female stocks and those with both female and hermaphrodite flowers are equal, or almost equal, in number to those bearing only hermaphrodite ones: in others they occur less frequently, and in still others they appear only very sporadically. In all species the female flowers are smaller than the larger hermaphrodite ones, but both vary considerably in size. In some species there are several sizes of female flowers, corresponding exactly to those of the typical hermaphrodite ones. The stigma in the smaller female flowers is usually fully receptive at the beginning of anthesis, but at this stage in the larger flowers of many species bearing markedly protandrous hermaphrodite ones, neither is the style fully developed nor the stigma mature. This peculiarity clearly shows how female flowers have been derived from protandrous hermaphrodite ones. Nectar is usually secreted in large quantities in most species, and often fills the bases of the more vertical flowers to a height of several millimetres. In nearly or quite horizontal ones it covers the bottom of the corolla-tube, usually in the form of one or several large drops. A protection against the penetration of water or the escape of nectar (in horizontal flowers) is provided by hairs which line the corolla-tube and usually cover the bases of the filaments as well. The nectaries of female flowers are smaller than those of hermaphrodite ones in proportion to the size of the flowers themselves.

Visitors belong to all groups of flower-visiting insects, for the flowers vary greatly in size, form, and colour; the rarest are beetles, the commonest bees and butterflies. Only the longest-tongued bees (especially humble-bees) and butterflies can reach the nectar in flowers of many species; the latter, however, being generally unbidden guests. Many species are robbed of their nectar by perforating humble-bees, as the considerable depth of the corolla-tube prevents legitimate sucking, or at least renders it difficult.

698. Ocimum Tourn.

The nectar stored in the corolla-tube is protected by hairs on the upper filaments. In the first stage of anthesis the stamens bend upwards and the style downwards; in the second this movement is reversed, so that insect visitors touch either anthers or stigma only, and cross-pollination is effected.

Visitors.—Delpino only saw bees—sp. of Apis, Bombus, Anthidium, and Halictus.

699. Plectranthus L'Hérit.

2219. P. fruticosus L'Hérit. (Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870, pp. 657–8.)—In the protandrous flowers of this species the style with immature stigma at first lies hidden among the stamens, which are situated below the entrance of a spur-like outgrowth from the base of the corolla serving as a nectar-receptacle. The stamens bend downwards later on, while the stigmatic branches diverge, so that these only are now exposed to contact with visitors.

2220. P. glaucocalyx Maxim. (Loew, Ber. D. Bot. Ges., Berlin, iv, 1886, pp. 657–8.)—This species, indigenous to East Asia, bears small, whitish flowers, generally provided with four blue spots above their entrance, serving as nectar-guides. The corolla-tube is 3 mm. long, the flowers belonging therefore to class **C.** In the first stage of anthesis, the style and stamens rest on the lower lip, the stigmatic branches being still apposed. In the second stage, the style moves upwards, the upper and longer stigmatic branch bending upwards rather strongly, while the lower and shorter one remains horizontal.

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Diptera. (*a*) *Muscidae*: 1. Echinomyia fera *L.*; 2. Lucilia caesar *L.* (*b*) *Stratiomyidae*: 3. Chrysomyia formosa *Scop.* (*c*) *Syrphidae*: 4. Eristalis arbustorum *L.* **B. Hymenoptera.** *Apidae*: all skg.: 5. Apis mellifica ☿; 6. Halictus cylindricus *F.* ♂; 7. H. sexnotatus *K.* ♀.

2221. P. striatus Benth. (Breitenbach, Kosmos, Stuttgart, xv, 1884.)—Breitenbach says that the flowers of this species are protandrous in the Botanic Gardens at Marburg and Gottingen, and that the upper ones are female.

700. Lavandula Tourn.

Protandrous, very fragrant bee flowers. The stamens and the style are enclosed in the bilabiate corolla. Nectar is secreted by the base of the ovary, as usual. Gynodioecious. Medicus and Heckel state that the stigmas of L. dentata, L. latifolia, and L. bicolor are sensitive.

2222. L. vera DC. (= L. officinalis *Chaix*). (Herm. Müller, 'Fertilisation,' pp. 469–70, 'Weit. Beob.,' III, pp. 59–60; Kirchner, 'Flora v. Stuttgart,' pp. 606–7; Schulz, 'Beiträge,' II, p. 194; Knuth, 'Bloemenbiol. Bijdragen.')—The small, blue, aromatic flowers of this species secrete abundant fragrant nectar from the highly developed nectary, and this is stored at the base of the corolla-tube (6 mm. long), and protected from rain by a ring of hairs. Schulz says that the flowers are gynodioecious. The anthers of the hermaphrodite flowers dehisce at the very beginning of anthesis, and lie on the upper lip, turning their pollen-covered surfaces upwards. At first the style with its immature stigma does not reach to the middle of the corolla-tube, so that although insects remove pollen, they cannot act as pollinators. As the stamens fade, the style elongates to about 1½ times its original length during which process pollen easily clings to the still apposed stigmatic lobes. These then diverge, and cross-pollination is brought about by insect-visits, for the pollen of the same flower has already been removed. Should such visits fail, automatic self-pollination finally takes place, the style elongating until it reaches the two lower anthers.

Visitors.—Knuth (Kiel Botanic Garden) only saw the honey-bee, freq., skg. Herm. Müller gives the following list for Thuringia.—

A. Hymenoptera. *Apidae*: 1. Anthidium manicatum *L.* ♀ and ♂, freq., especially the ♂, skg.; 2. Anthophora quadrimaculata *Pz.* ♀ and ♂, freq., skg.; 3. Apis mellifica *L.* ☿, in great numbers, skg.; 4. Chelostoma nigricorne *Nyl.* ♂, skg.; 5. Coelioxys conoidea *Ill.* ♀, numerous, skg.; 6. C. rufescens *Lep.* ♀ and ♂, do.; 7. Crocisa scutellaris *F.* ♀ and ♂, do.; 8. Megachile centuncularis *L.* ♂, skg.; 9. M. fasciata *Sm.* ♀ and ♂, the ♂ numerous, skg.; 10. M. willughbiella *K.* ♂, in

large numbers, skg.; 11. Melecta armata *Pz.* ♀, skg.; 12. Osmia adunca *Latr.* ♂, do.; 13. O. aenea *L.* ♀ and ♂, the ♂ numerous, skg.; 14. O. fulviventris *Pz.* ♀, skg.; 15. O. rufa *L.* ♀, do. **B. Lepidoptera.** (*a*) *Geometridae*: 16. Acidalia virgularia *Hbn.*, skg. in the evening; 17. Halia wauaria *L.*, do. (*b*) *Noctuidae*: 18. Agrotis exclamationis *L.*, do.; 19. A. latens *Hbn.*, do.; 20. Plusia gamma *L.*, do; 21. P. triplasia *L.* do. (*c*) *Pyralidae*: 22. Eurrhypara urticata *L.*, skg. in the evening. (*d*) *Rhopalocera*: 23. Pieris sp., skg.; 24. Epinephele janira *L.*, do. **C. Thysanoptera.** 25. Thrips, freq. in the flowers.

2223. L. Stoechas L.—Kerner says that the flowers of this South European species possess conspicuous blue bracts, projecting beyond the corollas on the upper part of the spikes, and greatly enhancing their conspicuousness.

701. Elsholtzia Willd.

2224. E. cristata Willd. (= E. Patrini *Garcke*, and Mentha Patrini *Lepech.*).—The mint-like smell of the whole plant in this species tends to attract insects. The small, bright-coloured flowers grow in unilateral racemes turning outwards. The slightly curved corolla-tube is 2 mm. broad at its mouth, scarcely one mm. broad and only 3 mm. long at its base, so that nectar is accessible even to short-tongued insects. Self-pollination is at first prevented by protandry; later on it may take place automatically, as the stigma is then situated between the upper, shorter anthers, and these are still covered with pollen.

Visitors.—Knuth observed the following in the Kiel Botanic Garden (30. 8. '98).—

Thrips, and skg. Diptera, i. e. 2 hover-flies (Ascia podagrica *F.*, and Eristalis tenax *L.*), and Muscids—Lucilia caesar *L.*, Sarcophaga carnaria *L.*, and several medium-sized sp.

702. Coleus Lour.

2225. C. Blumei Benth. (?) (Delpino, 'Ult. oss.,' pp. 143–4; Herm. Müller, 'Weit. Beob.,' III, pp. 58–9.)—The flowers of this species deviate considerably from the Labiate type, and approximate to those of Papilionaceae. According to the descriptions of Delpino and Hermann Müller, the upper lip is modified into a kind of carina surrounding the stamens and style, while the lower part of the corolla-limb forms a small vexillum. Below this is the entrance to the nectar concealed in the base of the corolla-tube. By placing itself on the carina and inserting its proboscis into the corolla-tube, a bee depresses the easily movable carina, and touches either the stigma or the pollen-covered anthers, as the case may be, so that cross-pollination is always effected.

703. Mentha L.

Gynodioecious or gynomonoecious flowers, growing in conspicuous whorls. Nectar is secreted and concealed in the usual way. The hermaphrodite flowers are protandrous and larger than the female ones, which are most frequent at the beginning of the flowering season. Darwin describes some species as dimorphous. The leaves and flowers are strongly aromatic.

2226. M. arvensis L. (Herm. Müller, 'Fertilisation,' pp. 470–1; Kirchner, 'Flora v. Stuttgart,' p. 610; Schulz, 'Beiträge,' II; Knuth, 'Bloemenbiol. Bijdragen'; Möwes, Bot. Jahrb., Leipzig, iv, 1883.)—In this species the very large nectary

situated beneath the ovary secretes abundant nectar, which is concealed in the base of the corolla-tube; in hermaphrodite flowers this is about 3 mm., and in female ones about 2 mm. long. The mouth of the flower is fully 1½ mm. and one mm. in diameter respectively. The nectar is therefore accessible even to short-tongued insects. It is protected from rain by hairs reaching from the inner surface of the corolla-tube to its middle. Hermann Müller states from actual observation that the large, and therefore more conspicuous, hermaphrodite stocks are first visited by insects, and the smaller, less conspicuous female ones afterwards. Gynomonoecious stocks may be rare, or sporadically may be the only ones present. Hermaphrodite and female ones are about equally numerous.

Möwes also found the species to be gynodioecious, with large-flowered hermaphrodite and small-flowered female stocks.

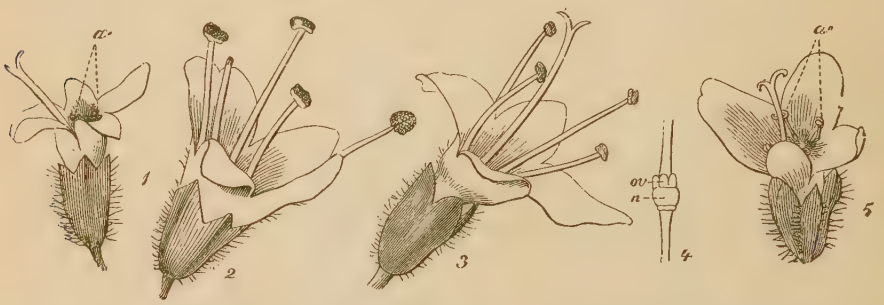


FIG. 326. *Mentha, L.* (after Herm. Müller). (1–4) *Mentha arvensis, L.* (1) Female flower. (2) Hermaphrodite do., in the first (male) stage. (3) Do., in the second (female) stage. (4) Ovary (*ov*) and nectary (*n*). (5) *Mentha aquatica, L.* Female flower seen obliquely from the front, to show the vestigial stamens, foreshortened. a^1, vestigial stamens. (1) and (5) should be supposed twisted round to the right into a horizontal position.

Schulz says that the species is gynomonoecious and gynodioecious, and that occasionally 50 % or more of the stocks are female. In other stations purely gynomonoecious plants are to be found. He adds that the female flowers are visited by insects quite as frequently as the hermaphrodite ones. Warnstorf observed both gynomoecism and gynodioecism at Ruppin.

VISITORS.—Knuth observed the following.—

A. Diptera. (*a*) *Muscidae*: 1. Lucilia caesar *L.*, skg. (*b*) *Syrphidae*: 2. Syritta pipiens *L.*, skg. and po-dvg.; 3. Syrphus balteatus *Deg.* ♂, do.; 4. S. ribesii *L.*, do. **B. Hymenoptera.** *Apidae*: 5. Apis mellifica *L.* ☿, very common, skg.; 6. Bombus terrester *L.* ☿, skg.

Herm. Müller gives the following list of insects, all skg.—

A. Diptera. (*a*) *Muscidae*: 1. Lucilia albiceps *Mg.*, not infreq.; 2. L. cornicina *F.*, do.; 3. L. sylvarum *Mg.*, do.; 4. Onesia floralis *R.-D.*, freq.; 5. O. sepulcralis *Mg.*, do.; 6. Pyrellia cadaverina *L.*, not infreq. (*b*) *Stratiomyidae*: 7. Odontomyia viridula *F.* (*c*) *Syrphidae*: 8. Eristalis sepulcralis *L.*, very common; 9. Melithreptus scriptus *L.*, not infreq., skg.; 10. M. taeniatus *Mg.*, do.; 11. Syritta pipiens *L.*, freq. **B. Lepidoptera.** *Rhopalocera*: 12. Epinephele janira *L.*

The following were recorded by the observers, and for the localities stated.—

Verhoeff (Norderney), the Muscid Lucilia latifrons *Schin.* MacLeod (Flanders), a hover-fly (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 364). Scott-Elliot (Dumfriesshire), several Muscids and beetles ('Flora of Dumfriesshire,' p. 135).

2227. M. piperita L. (Knuth, 'Blütenbiol. Herbstbeob.')—

Visitors.—Knuth (Kiel Botanic Garden) observed, skg., the honey-bee, a hover-fly (Eristalis sp.), and a butterfly (Pieris sp.). Loew gives the following list for the Berlin Botanic Garden.—

A. Coleoptera. (*a*) *Alleculidae*: 1. Cteniopus sulphureus *L.* (*b*) *Coccinellidae*: 2. Coccinella bipunctata *L.* **B. Diptera.** (*a*) *Muscidae*: 3. Echinomyia fera *L.*, numerous; 4. Lucilia caesar *L.*; 5. Sarcophaga carnaria *L.* (*b*) *Syrphidae*: 6. Eristalis arbustorum *L.*; 7. E. nemorum *L.*; 8. Helophilus floreus *L.*; 9. Syritta pipiens *L.*; 10. Syrphus corollae *F.*

2228. M. aquatica L. (Herm. Müller, 'Fertilisation,' p. 471, 'Weit. Beob.,' III, p. 58; Kirchner, 'Flora v. Stuttgart,' p. 609; Schulz, 'Beiträge,' II, pp. 126, 174, 195; Loew, 'Blütenbiol. Floristik,' p. 390; Knuth, 'Bloemembiol. Bijdragen'; Möwes, op. cit.)—Schulz says that gynomonoeciously and still more frequently gynodioeciously distributed female flowers are found in this species as well as protandrous hermaphrodite ones. Möwes found the var. *capitata* Wimm. to be represented by large-flowered hermaphrodite and small-flowered female stocks. The corolla-tube of hermaphrodite flowers is 4–5 mm. long, with an entrance 2 mm. broad. The flower mechanism agrees otherwise with that of M. arvensis. The stocks bearing hermaphrodite flowers are much more frequent than the small-flowered female ones, the latter generally occurring, according to Schulz, to the amount of 5–15 %. Although the nectar is concealed somewhat more deeply than in M. arvensis, the species is more largely visited by insects, on account of the greater conspicuousness of the inflorescences.

Visitors.—Herm. Müller observed the following.—

A. Coleoptera. *Cerambycidae*: 1. Leptura testacea *L.* **B. Diptera.** (*a*) *Empidae*: all skg.; 2. Empis livida *L.*, freq.; 3. E. rustica *Fall.*; 4. E. tessellata *F.* (*b*) *Muscidae*: all skg.; 5. Lucilia caesar *L.*; 6. Musca corvina *F.*; 7. Onesia floralis *R.-D.*; 8. O. sepulcralis *Mg.*; 9. Sarcophaga carnaria *L.* (*c*) *Syrphidae*: 10. Ascia podagrica *F.*, skg.; 11. Eristalis aeneus *Scop.*, very common, skg. and po-dvg.; 12. E. arbustorum *L.*, do.; 13. E. intricarius *L.* ♀, freq., skg.; 14. E. nemorum *L.*, very common, skg. and po-dvg.; 15. E. pertinax *Scop.*, skg.; 16. E. sepulcralis *L.*, very common, skg. and po-dvg.; 17. Helophilus floreus *L.*, skg.; 18. H. pendulus *L.*, freq., skg. and po-dvg.; 19. H. trivittatus *F.*, do.; 20. Melanostoma mellina *L.*, freq., do.; 21. Rhingia rostrata *L.*, skg.; 22. Syritta pipiens *L.*, freq., skg. and po-dvg.; 23. Syrphus pyrastri *L.*, do. (*d*) *Tabanidae*: 24. Chrysops caecutiens *L.*, skg. **C. Hymenoptera.** (*a*) *Apidae*: 25. Apis mellifica *L.* ☿, freq., skg.; 26. Halictus cylindricus *F.* ♂, do.; 27. H. longulus *Sm.* ♀, skg.; 28. H. maculatus *Sm.* ♂, freq., skg.; 29. H. nitidiusculus *K.* ♂, skg. (*b*) *Ichneumonidae*: 30. Various sp., sometimes creeping right into the flowers. **D. Lepidoptera.** *Tortricidae*: 31. Tortrix sp., skg. **E. Neuroptera.** 32. Panorpa communis *L.*, skg.

Willis noticed the following in the neighbourhood of the S. coast of Scotland ('Fls. and Insects in Gt. Britain,' Part I).—

A. Coleoptera. (*a*) *Curculionidae*: 1. Crepidodera ferruginea *Scop.*, freq., dvg. pollen and anthers. (*b*) *Nitidulidae*: 2. Meligethes sp., skg. and po-dvg. **B. Diptera.** (*a*) *Empidae*: 3. Rhamphomyia sp., skg. (*b*) *Muscidae*: 4. Anthomyia radicum *L.*, skg. and po-dvg.; 5. Mydaea sp., po-dvg.; 6. Trichopthicus cunctans *Mg.*, freq., skg. (*c*) *Syrphidae*: 7. Eristalis aeneus *Scop.*, freq., skg.; 8. E. horticola *Deg.*, do.; 9. E. tenax *L.*, do.; 10. Volucella pellucens *L.*, skg. **C. Hymenoptera.**

Apidae: 11. Bombus agrorum *F.*, freq., skg.; 12. Halictus rubicundus *Chr.*, skg.; 13. Psithyrus campestris *Pz.*, do. **D. Lepidoptera.** *Rhopalocera*: 14. Pieris napi *L.*, skg.; 15. Polyommatus phlaeas *L.*, do.; 16. Vanessa urticae *L.*, do.

Burkill gives the following list for the E. coast of Scotland.—

A. Coleoptera. *Nitidulidae*: 1. Cercus rufilabris *Ltr.*, skg.; 2. Meligethes aeneus *F.*, do.; 3. M. picipes *Sturm.*; 4. Pria dulcamara *Scop.*, skg. **B. Diptera.** (*a*) *Bibionidae*: 5. Bibio lepidus *Lw.*; 6. Scatopse brevicornis *Mg.*, skg. and *in copula.* (*b*) *Muscidae*: 7. Anthomyia brevicornis *Zett.*, skg.; 8. A. radicum *L.*, skg. and po-dvg.; 9. Calliphora erythrocephala *Mg.*, skg.; 10. Coelopa sp., skg. and po-dvg.; 11. Ensina sonchi *L.*; 12. Lonchoptera sp.; 13. Lucilia cornicina *F.*, skg. and po-dvg.; 14. Morellia importuna *Hal.*, skg.; 15. Oscinis frit *L.*, do.; 16. Sarcophaga carnaria *L.*, do.; 17. S. sp., do.; 18. Scatophaga stercoraria *L.*; 19. Sepsis cynipsea *L.*; 20. Siphona geniculata *Deg.*, skg. and po-dvg.; 21. Stomoxys calcitrans *L.*, do. (*c*) *Phoridae*: 22. Phora sp. (*d*) *Syrphidae*: 23. Arctophila mussitans *F.*, skg.; 24. Eristalis arbustorum *L.*, do.; 25. E. horticola *Deg.*, do.; 26. E. pertinax *Scop.*, do.; 27. E. tenax *L.*, do.; 28. Helophilus pendulus *L.*, do.; 29. Platycheirus albimanus *F.*; 30. P. manicatus *Mg.*; 31. P. scutatus *Mg.*, skg.; 32. Syritta pipiens *L.*, do.; 33. Syrphus balteatus *Deg.*; 34. S. corollae *F.*; 35. S. ribesii *L.* (*e*) *Tipulidae*: 36. Anopheles sp., apparently skg.; 37. Pericoma sp.; 38. Sciara sp. **C. Hemiptera.** 39. Heterocordylus sp., freq., creeping about the inflorescences. **D. Hymenoptera.** (*a*) *Apidae*: 40. Bombus agrorum *F.*, skg.; 41. B. hortorum *L.*, do.; 42. B. lapidarius *L.*, do. (*b*) *Ichneumonidae*: 43. 12 undetermined sps. **E. Lepidoptera.** (*a*) *Noctuidae*: 44. Plusia gamma *L.*, skg. (*b*) *Rhopalocera*: 45. Vanessa urticae *L.*, skg. (*c*) *Microlepidoptera*: all skg.; 46. Chilo (Crambus) furcatellus *Zett.*; 47. Plutella cruciferarum *Zett.*; 48. Mimaescoptilus pterodactylus *L.* **F. Thysanoptera.** 49. Thrips sp., very common.

The following are recorded by the observers, and for the localities stated.—

Knuth (Glücksburg), the humble-bee Bombus sylvarum *L.* ♀, skg. Loew (Brandenburg), the hover-fly Melithreptus scriptus *L.*, skg. ('Beiträge,' p. 41): (Berlin Botanic Garden), the Muscid Lucilia caesar *L.*, and the Syrphid Syritta pipiens *L.* MacLeod (Flanders), the honey-bee, 6 Syrphids, 2 Muscids, 5 Lepidoptera, and a Neuropterid (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 364, vi, 1894, p. 371). H. de Vries (Netherlands), the humble-bee Bombus agrorum *F.* ♀ (Ned. Kruidk. Arch., Nijmegen, 2 Ser., 2 Deel, 1875). E. D. Marquard (Cornwall), 2 bees—Andrena fulvicrus *K.*, and A. pilipes *Rossi.* Scott-Elliot (Dumfriesshire), 2 humble-bees, 5 hover-flies, several Muscids, 3 Lepidoptera, and several beetles ('Flora of Dumfriesshire,' p. 135).

2229. M. gentilis L. (Schulz, 'Beiträge,' II, pp. 126–7; Kirchner, 'Flora v. Stuttgart,' p. 609; Möwes, Bot. Jahrb., Leipzig, iv, 1883, pp. 189 et seq.)—In this species Möwes found the same difference in the respective sizes of hermaphrodite and female (gynodioecious) flowers as in the two preceding ones. As these, however, are sterile, he does not consider M. gentilis a species, but a hybrid between M. aquatica *L.* and M. arvensis *L.* Schulz says that the female form sometimes predominates (e. g. in Thuringia), or is even the only one present. He also states that flowers with normal stamens are occasionally to be found.

2230. M. rotundifolia Huds.—Schulz ('Beiträge,' II, p. 195) says that this species occurs gynomonoeciously and gynodioeciously with protandrous hermaphrodite flowers.

2231. M. sylvestris L. (Herm. Müller, 'Alpenblumen,' p. 325; Schulz,

'Beiträge,' II, p. 195; Loew, 'Blütenbiol. Floristik,' p. 398.)—Schulz says that this species also is sometimes gynomonoecious, and sometimes, though less frequently, gynodioecious with strongly protandrous hermaphrodite flowers. The latter are about 3 mm. long, and the female ones are only a little smaller, with reduced stamens. Sometimes only gynomonoecious stocks are found. Heinsius states that the hermaphrodite flowers in Holland are homogamous, and that purely female stocks also occur there.

Visitors.—Heinsius gives the following list for Holland.—

A. Diptera. (*a*) *Conopidae*: 1. Conops quadrifasciatus *Deg.* ♂. (*b*) *Muscidae*: 2. Echinomyia magnicornis *Zett.* ♂; 3. E. tessellata *F.* ♀; 4. Sarcophaga sp. ♀. (*c*) *Syrphidae*: 5. Eristalis arbustorum *L.* ♂ and ♀; 6. E. nemorum *L.* ♂; 7. Melithreptus dispar *Lw.* ♂. **B. Hymenoptera.** (*a*) *Apidae*: 8. Andrena nigriceps *K.* ♀; 9. Apis mellifica *L.* ☿; 10. Halictus flavipes *F.* ♀; 11. H. zonulus *Sm.* ♂; 12. Psithyrus vestalis *Fourcr.* ♂; 13. Sphecodes gibbus *L.* ♂. (*b*) *Sphegidae*: 14. Ammophila sabulosa *L.*; 15. Cerceris variabilis *Schr.*; 16. Oxybelus trispinosus *F.* ♂. **C. Lepidoptera.** *Rhopalocera*: 17. Coenonympha pamphilus *L.*; 18. Epinephele hyperanthus *L.*; 19. Lycaena aegon *W.V.* ♀; 20. Pieris napi *L.* ♂.

The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 8 flies, 5 Hymenoptera, and 3 Lepidoptera. Schletterer (Tyrol), 2 bees—Halictus morbillosus *Krchb.*, and Sphecodes gibbus *L.* von Dalla Torre (Tyrol), the Vespid Eumenes puniformis *F.* Loew (Tyrol), the hover-fly volucella inanis *L.* ('Beiträge,' p. 50): (Berlin Botanic Garden), **A. Diptera.** (*a*) *Muscidae*: 1. Lucilia caesar *L.* (*b*) *Syrphidae*: 2. Eristalis nemorum *L.*; 3. Syritta pipiens *L.*; 4. Syrphus balteatus *Deg.* **B. Hymenoptera.** *Vespidae*: 5. Odynerus parietum *L.*, var. renimacula *Lep.*; also in the var. *abyssinica* the hover-fly Syritta pipiens *L.*, and in the var. *nemorosa L.* Willd. the hover-fly Eristalis nemorum *L.* MacLeod (Pyrenees), 4 Hymenoptera, 5 Lepidoptera, 2 beetles, 4 hover-flies, and 4 Muscids (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 324–5).

2232. M. Pulegium L. (Schulz, 'Beiträge,' II, p. 195.)—This species also possesses gynomonoeciously and gynodioeciously distributed female flowers, as well as protandrous hermaphrodite ones.

704. Lycopus Tourn.

Gynomonoecious or gynodioecious, or protandrous hermaphrodite flowers with concealed nectar. The female flowers are generally smaller than the hermaphrodite ones.

2233. L. europaeus L. (Herm. Müller, 'Fertilisation,' pp. 471–2; Schulz, 'Beiträge,' II, pp. 125–6; Knuth, 'Bl. u. Insekt. a. d. nordfr., Ins.,' pp. 117, 165, 'Bloemenbiol. Bijdragen'; Kirchner, 'Flora v. Stuttgart,' p. 610.)—The small white flowers of this species generally possess nectar-guides in the form of red spots on the lower lip. The corolla-tube of the hermaphrodite flowers is only 3–4 mm. long, about 2½ mm. wide at the entrance, and scarcely a mm. wide at the base. The secretion of nectar is, as usual, effected by the large, fleshy base of the ovary. The inner surface of the corolla-tube is closely beset with vertical hairs to protect the nectar from rain. The latter is accessible even to very short-tongued insects, as the corolla-tube is short and wide.

In the first stage of anthesis, the two mature stamens with pollen-covered anthers project from the flower, while both stigmatic branches are still apposed. In the

second stage, the stamens are withered and curve downwards, and the mature stigma is situated in the mouth of the flower. Automatic self-pollination is therefore excluded. The reduction of the second pair of stamens is (according to Hermann Müller) simply a result of the smallness of the flower.

All four stamens are frequently reduced. The female flowers are often only ½–1 mm. long. They are sometimes to be found on separate stocks, sometimes on those also bearing hermaphrodite flowers. The purely or largely female stocks are vegetatively stronger than those which are entirely or mainly hermaphrodite.

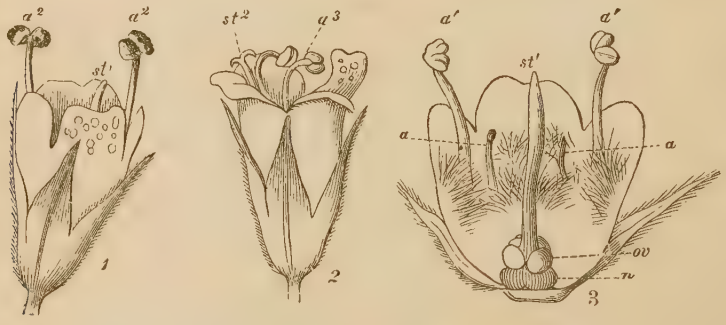


FIG. 327. *Lycopus europaeus*, *L.* (after Herm. Müller). (1) Flower in the first (male) stage, seen from below. (2) Do., in the second (female) stage, seen from the side. (This figure must be supposed twisted round to the right into a horizontal position.) (3) Do., in the first stage, spread out after removal of the lower lip, seen from below. *a*, vestigial anthers; a^1, a^2, and a^3, fertile anthers before dehiscence, during dehiscence, and when withered; *n*, nectary; *ov*, ovary; st^1 and st^2, immature and mature stigma.

VISITORS.—Herm. Müller observed the following in Westphalia and Thuringia.—

A. Diptera. (*a*) *Muscidae*: 1. Lucilia cornicina *F.*, in large numbers, skg.; 2. L. sylvarum *Mg.*, do.; 3. Pollenia vespillo *F.*, skg.; 4. Sarcophaga albiceps *Mg.*, freq., skg. (*b*) *Culicidae*: 5. numerous small gnats (1½ mm. long). (*c*) *Syrphidae*: 6. Melithreptus scriptus *L.*, skg. and po-dvg.; 7. Syritta pipiens *L.*, very common, do. **B. Hemiptera**. 8. Undetermined sp. **C. Hymenoptera**. *Vespidae*: 9. Polistes gallica *L.*; 10. P. diadema *Ltr.*, in large numbers (Thuringia), both skg. **D. Lepidoptera**: 11. Adela sp., skg. **E. Thysanoptera**. 12. Thrips, very numerous.

The following were recorded by the observers, and for the localities stated.—

Knuth (Schleswig Holstein), a humble-bee (Bombus sylvarum *L.* ♀, skg.), an ichneumon fly (Bassus tarsatorius *Pz.*, skg.), and 2 hover-flies (Syritta pipiens *L.*, and S. ribesii *L.*, both skg.). MacLeod (Flanders), the honey-bee, a humble-bee, 3 short-tongued bees, 5 hover-flies, 4 Muscids, 3 Vespids, and a Lepidopterid (Bot. Jaarb. Dodonaea, Ghent, iv, 1892, p. 372; v, 1893, pp. 365–6).

2234. L. exaltatus L. fil.—Schulz ('Beiträge,' II, p. 195) states that this species is gynodioecious, judging from herbarium material.

705. Salvia L.

LITERATURE.—Sprengel, 'Entd. Geh.,' pp. 58–62; Hildebrand, 'Ü. d. Befrucht. d. Salbei-Arten durch. Insekt.'; Correns, 'Zur Biol. u. Anat. d. Salvienblüte'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 262–3.

Generally protandrous, rarely homogamous, frequently gynodioecious humble-bee

or bee flowers with two stamens, of which the connective is modified into a two-armed lever. The upper anther-lobe, containing pollen, is generally concealed under the upper lip, and thus protected from rain. A humble-bee probing for the nectar secreted at the bottom of the flower by the base of the ovary strikes its head against the generally sterile lower anther-lobe, which is situated in the mouth of the corolla. In this way the fertile upper lobe is brought down on to the back of the insect which is using the lower lip as a platform, and dusts it with pollen. This is transferred to the stigma of a flower in the second stage, when the diverging stigmatic branches, with mature papillae, are situated in the entrance of the flower, and must be touched first by visitors.

The highest specialization of this lever mechanism is reached in S. glutinosa *L.* In other species the 'hammer mechanism' as Kerner, or 'turnpike mechanism' as Hermann Müller calls it, is not so perfect, and sometimes the upper lip itself is movable, instead of the connective (S. verticillata *L.*), or the style and fertile anther-lobes are not enclosed in the corolla (S. tubiflora *Sm.*). Those species in which there is a movable joint between filament and connective differ (according to Correns) to this extent, that in one group the lower half of the connective serves not only as a surface to be struck against, but also as a nectar-cover (S. pratensis *L.*, S. sylvestris *L.*, S. Horminum *L.*, S. hispanica *L.*, S. tilifolia), while in a second group there is a special nectar-cover provided (S. glutinosa *L.*, &c.).

Delpino states that in some species there are special adhesive spherules on the anthers (S. verticillata *L.*, S. officinalis *L.*, and S. Sclarea *L.*), assisting the pollen-grains to cling more closely to visitors. Correns does not confirm this opinion, but says these are ordinary glandular hairs, occurring in other species of Salvia on the most various parts of the flowers, even on those which are never touched by insects. The view expressed by Delpino about the oecological meaning of these structures would therefore appear to be untenable. Brightly coloured bracts serve to increase the conspicuousness of the flowers in many species (S. Horminum *L.*, S. sylvestris *L.*, and S. Sclarea *L.*).

2235. S. pratensis L. (Sprengel, loc. cit.; Axell, 'Om Anord. för Fanerog. Växt. Befrukt.,'; Hildebrand, op. cit.; Herm. Müller, 'Fertilisation,' pp. 477–9, 'Alpenblumen,' pp. 315–17, 'Weit. Beob.,' III, p. 55; Kirchner, 'Flora v. Stuttgart,' p. 616; Schulz, 'Beiträge,' I, p. 78; II, pp. 127–9; Loew, 'Blütenbiol. Floristik,' pp. 392, 400; Correns, op. cit.; Knuth, 'Bloemenbiol. Bijdragen.')—In this species the corolla is usually dark-blue in colour, and directed horizontally. Its tube conceals the nectar secreted by the yellow, fleshy base of the ovary. The lower lip forms a convenient and safe platform for nectar-seeking bees, while the galeate upper lip serves as a protective roof for the fertile anther-lobes. The entrance to the corolla-tube is closed by a plate made up of the two spoon-shaped sterile limbs of the connectives, which fuse together in the course of anthesis. The fertile limbs are about three times as long as the sterile ones. As Sprengel observed, there is a movable union between the filament and connective. Correns says that the joint is not a cylindrical one, but a genuine torsion-joint, distinguished by a remarkable elasticity: it can be twisted artificially through 180°, while an insect visitor only moves it 35°–60°.

This joint is kept in place by a shell-shaped broadening of its end ('joint-

cushion'). When an insect pushes its head into the flower, the connective-plate blocking the entrance is pressed upwards and backwards, so that the fertile anther-lobes, covered with pollen below, are twisted forwards and downwards.

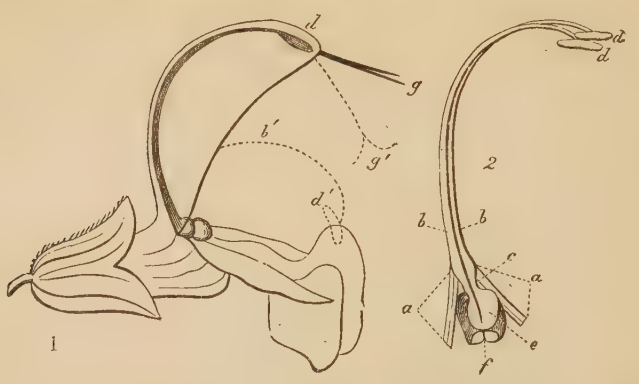


FIG. 328. *Salvia pratensis*, *L.* (after Herm. Müller). (1) Flower seen from the right. (2) Stamens seen from the right front (× 2). *a*, filaments; *b* and *c*, upper and lower limbs of the connectives; *d*, upper anther-lobes; *e*, lower do. modified into a plate closing the entrance to the corolla-tube; *f*, point where the two lower anther-lobes are united; *g*, style in the first stage; *g'*, do. in the second stage. The dotted line *b' d'* indicates the position assumed by the anthers when twisted down.

In this way not only is the entrance to the nectar opened, but the fertile anther-lobes are brought down on to the visitor's back, dusting it with pollen. When the insect withdraws its head from the flower, the anthers resume their former position.

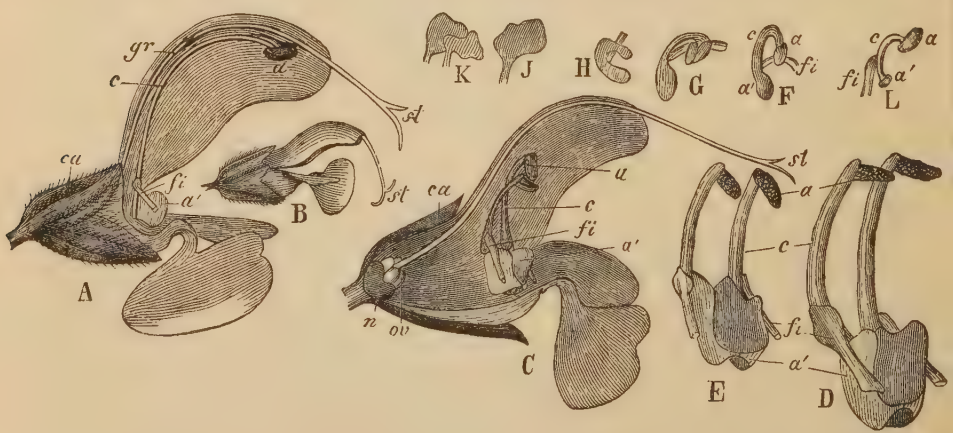


FIG. 329. *Salvia pratensis*, *L.* (after Herm. Müller). *A*. Large flower, after removal of part of the corolla. *B*. Small do. (× 2). *C*. Do., more strongly magnified. *D–K*. Stamens in various stages of reduction (× 7). *L*. A stamen of *S. officinalis*, *L.* *a* and *a'*, upper and lower anther-lobes; *c*, connectives; *ca*, calyx; *fi*, filaments; *gr*, style; *n*, nectary; *ov*, ovary; *st*, stigma.

In older flowers the stigmatic surfaces are situated in the entrance, so that insects brush against them first. They mature until the anthers have dehisced. Hermann Müller says, therefore, that automatic self-pollination is excluded. He observed small-flowered female stocks in the Alps as well as the large-flowered hermaphrodite form, the lever-mechanism in the former being reduced to a variable extent. The less

reduced forms are set in motion by humble-bees, but, of course, uselessly for the plant. In extreme cases the stamens are reduced to small lobes (Fig. 329). Correns says that in these flowers with a small perianth the spoon-shaped parts of the connectives are retained, while the rest of the anthers are reduced. It follows that not only is the nectar protected from unbidden guests, but that bee visitors are compelled to suck these smaller flowers in the same way as the larger ones, so that their stigmas must be pollinated from the latter. Gynomonoecious as well as hermaphrodite and female stocks are to be found.

Schulz recognizes four forms occurring in Germany.—

(1) Large-flowered hermaphrodite form: corolla 27–29 mm. long; mouth 9–10 mm.; connectives 15–18 mm.; pistil 32–42 mm. long. Protandrous or homogamous; in the latter case automatic self-pollination is possible, as the stigma is placed in the line of fall of the pollen. This form is connected by transition stages with the following:

(2) Small-flowered hermaphrodite form: corolla 16–23 mm. long; mouth 6–8 mm.; connective 8–16 mm.; pistil 25–35 mm. long. Usually homogamous, or feebly, rarely markedly protandrous; automatic self-pollination is easily possible when the style is long.

(3) Large-flowered female form: corolla 19–24 mm. long; 6–7 mm. high; pistil 28–34 mm.; connectives, on an average, 6 mm. long. The lever mechanism is more or less reduced, the anthers sometimes normal, but devoid of mature pollen.

(4) Small-flowered female form: corolla 10–15 mm. long, 5–6 mm. high; connectives usually 3–4 mm. long, but sometimes entirely absent. Anthers minute. Pistil 20–25 mm. long, often projecting far out of the flower, on account of the smallness of the latter.

Besides stocks bearing only these four forms, there are others with both female and hermaphrodite flowers. The various forms grow either in different whorls, in which case the female flowers are generally at the top of the inflorescence, or they are arranged in whorls of three made up of mixed forms, of which the lateral ones are female. Schulz found the flowers in the lower parts of the South Tyrol smaller on an average than those in Germany; here the length of the corolla varies usually between 18–22 mm., the height of the flower entrance between 6–9 mm., the length of the style between 23–36 mm. The size of the flower may sometimes be no more than 12 or even 10 mm. The flowers in the lower parts of the South Tyrol are feebly protandrous, partly homogamous. Automatic self-pollination is possible both in flowers with a very short style and in those where this is considerably elongated, the stigma in the first case coming into immediate contact with the anthers, while in the second case it is brought into the line of fall of the pollen by the bending of the style downwards. This possibility of automatic self-pollination is important for both forms, since cross-pollination by insect-visits is not easily effected in either: in the first case the stigma does not reach down to the visitor's back, and in the second it generally touches that side of the insect not covered with pollen.

In the higher districts of the South Tyrol the size of the flowers again increases. Female stocks occur sporadically here, and in North Italy almost as frequently as hermaphrodite ones; gynomonoecious plants are also numerous. The size and form of the nectaries are equally varied; in small hermaphrodite forms and in female

flowers they are more feebly developed, but nectar is secreted to the same extent as in the large flowers. Insect-visits are equally numerous in the various types. Warnstorf describes the pollen-grains as yellow in colour, smooth, almost globular when examined in water, up to 56 μ in diameter.

There is a curious and abnormal form of the variety *apetala*, which Wetterhahn discovered and first described. This has been thoroughly examined by F. Pax from plants cultivated for years in the Berlin Botanic Garden. The description 'variety *apetala*' does not correspond to actual facts, for both perianth whorls are present. The calyx forms a bell-shaped tube, the corolla is green and consists of four small lancet-shaped or ovate petals. Stamens are absent; a number of style-like threads project from the corolla. There is, of course, no seed-formation; reproduction can only be effected vegetatively.

Geisenheyner (D. bot. Monatsschr., Arnstadt, xv, 1897) also observed at Kreuznach a reduction of the stamens in this species. The turnpike mechanism was absent, and therefore also the hinge-joint at the apex of the filament. The latter bore a connective, evidently formed by two united threads, facing only towards the side of the upper lip, and cleft at the tip into two somewhat unequal parts, each bearing a free anther-lobe. That attached to the longer part had already dehisced, and almost entirely shed its pollen; the other had not yet done so, and was still closely packed with pollen.

Visitors.—The pollinators are exclusively long-tongued bees. Other insects are unbidden guests. Herm. Müller (H. M.) and Buddeberg (Budd.) observed the following in Central and South Germany.—

A. Diptera. (*a*) *Bombyliidae*: 1. Bombylius canescens *Mik.*, skg. (H. M., Thuringia). (*b*) *Conopidae*: 2. Dalmannia punctata *F.*, in the flowers (Budd.). **B. Hymenoptera.** *Apidae*: 3. Andrena sp., ♂, skg. (H. M., Strasburg); 4. Anthidium manicatum *L.* ♀ and ♂, repeatedly skg. (H. M.); 5. Anthophora personata *Ill.* ♀ and ♂, skg. (H. M., Strasburg); 6. Bombus agrorum *F.* ☿, do. (H. M., Strasburg); 7. B. pratorum *L.* ♀, do. (H. M., Thuringia); 8. B. sylvarum *L.* ♀ and ☿, do. (H. M.); 9. Chelostoma nigricorne *Nyl.* ♂, do. (H. M., Strasburg; Budd.); 10. Eucera longicornis *L.* ♂, do. (Budd.); 11. Halictus villosulus *K.* ♀, creeping into the flowers (Budd.); 12. Megachile centuncularis *L.* ♂, skg. (H. M., Strasburg); 13. M. fasciata *Sm.* ♂, do. (H. M.); 14. M. sp. ♂, do. (H. M., Strasburg); 15. Osmia adunca, *Ltr.* ♂, do. (H. M., Strasburg; Budd.); 16. O. aenea *L.* ♀, do. (H. M., Strasburg); 17. O. rufa *L.* ♀, do. (H. M.); 18. Xylocopa violacea *L.*, do. (H. M., Strasburg). Unbidden guests were also noticed—butterflies (Pieris sp., also recorded by Sprengel), and the moth Plusia gamma *L.* Herm. Müller further records 5 small bees (1. Halictus morio *F.* ♀; 2. H. nitidiusculus *K.* ♀; 3. H. nitidus *Schenck* ♀; 4. H. sextrigatus *Schenck* ♀; 5. Prosopis communis *Nyl.* ♂ and ♀) obtaining nectar by operating the lever mechanism, but not sufficiently to be of use.

The following were recorded by the observers, and for the localities stated.—

Sprengel, Hildebrand, and Schulz, humble-bees. Knuth (Kiel Botanic Garden), 2 long-tongued bees—Bombus agrorum *F.* ♀, skg., and Eucera longicornis *L.* ♀ and ♂, do. Herm. Müller (Alps), 5 humble-bees, a beetle, and 10 Lepidoptera. Loew (Brandenburg) ('Beiträge,' p. 45).—**A. Hymenoptera.** *Apidae*: 1. Anthophora aestivalis *Pz.* ♂, skg.; 2. A. pilipes *F.* ♀, skg. and po-cltg.; 3. Bombus hortorum *L.* ♀, do.; 4. Halictus xanthopus *K.* ♀, po-cltg. **B. Lepidoptera.** *Sphingidae*: 5. Macroglossa bombyliformis *O.*, skg.: (Tyrol), the mason-bee Chalicodoma muraria *Retz.* ♀, skg. and po-cltg. (op. cit., p. 62): (Berlin Botanic Garden), the bee

Anthidium manicatum *L.* ♂, skg., ♀ visiting several flowers and then going to a white-flowered variety; and the humble-bee Bombus hortorum *L.* ☿, first settling on the calyx, but afterwards skg. legitimately. Schmiedeknecht (Thuringia), 4 bees—1. Bombus latreillellus *K.* (= B. subterraneus *L.*); 2. B. rajellus *K.* (= B. derhamellus *K.* ♀); 3. B. ruderatus *F.*; 4. B. soroënsis *F.* ♀. Friese (Thuringia), the humble-bee Bombus variabilis *Schmiedekn.* Rössler (Wiesbaden), the moth Agrotis ypsilon *Rott.* Hoffer (Steiermark), 2 bees—Bombus derhamellus *K.* ♀, and B. argillaceus *Scop.* Friese (Fiume, Mehadia, Trieste, *teste* Kolerič) and Dircke (Trieste), the bee Podalirius dufouri *Lep.* Schletterer (Tyrol), 4 bees—1. Bombus mastrucatus *Gerst.*; 2. B. muscorum *F.*; 3. B. subterraneus *L.*; 4. Melecta luctuosa *Scop.* von Dalla Torre (Tyrol), the humble-bee Bombus sylvarum *L.* ☿.

Loew (Berlin Botanic Garden) observed the following on the var. *variegata.*—

The Syrphid Platycheirus scutatus *Mg.*, hovering for a long time over a flower, and then settling on the lower lip; and 2 bees—Anthidium manicatum *L.* ♂, skg., and Apis mellifica *L.* ☿, skg. without result.

2236. S. sylvestris L. (Herm. Müller, 'Fertilisation,' p. 483, 'Weit. Beob.' III, p. 56; Correns, op. cit.; Delpino, op. cit.; Schulz, 'Beiträge,' I, pp. 78–9.)—The flower mechanism of this species agrees in the main with that of S. pratensis, but the corolla-tube is only 4 mm. long, so that short-tongued hymenoptera can easily reach the nectar. The form with small perianth examined by Correns also agrees with the corresponding one of S. pratensis as regards stamens. The anther-lobes of the free limbs of the connectives are fixed; the connectives (3 mm. long) are but very slightly movable. Though their spoon-shaped ends are united the joint between filament and connective is easily torn.

Schulz distinguished the following forms in Central Germany.—

(1) Large-flowered hermaphrodite form: corolla 10–12 mm. long; usually markedly protandrous.

(2) Medium-sized hermaphrodite form: completely homogamous; pistil extremely short; stigma situated entirely between the anthers, so that automatic self-pollination is inevitable (as e.g. near Halle).

(3) Small-flowered hermaphrodite form: corolla 7–8 mm. long; feebly protandrous or entirely homogamous.

(4) Large-flowered female form: corolla 9–11 mm. long; anthers a little smaller than the normal ones and devoid of pollen.

(5) Small-flowered female form: corolla 5–8 mm.; stamens sometimes completely aborted.

The two female forms usually appear on different stocks. Gynomonoecious plants generally bear only flowers with a large or small perianth.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel Botanic Garden), the humble-bee Bombus terrester *L.*, skg. Herm. Müller (Thuringia),—1. The honey-bee (proboscis 6 mm. long), po-cltg., and dusting the top of its head with pollen; 2. The Sphegid Psammophila affinis *K.* ♀ (proboscis 4 mm.), freq., skg.; also 2 butterflies as unbidden guests; 3. Pieris rapae *L.*, skg.; 4. P. napi *L.*, do. Schulz noticed occasional flowers perforated by humble-bees. Friese (Siebengebirge), 4 bees—1. Eucera armeniaca *Mor.*; 2. E. tricincta *Er.*; 3. Podalirius borealis *Mor.* (also in Hungary); 4. Meliturga clavicornis *Ltr.* Loew (Berlin Botanic Garden), the bee Apis mellifica *L.* ☿, skg., and thickly dusting its thorax with pollen; also on the var. *nemorosa.*

2237. S. glutinosa L. (Sprengel, 'Entd. Geh.,' p. 63; Herm. Müller, 'Fertilisation,' pp. 481–2, 'Alpenblumen,' pp. 317–18; Ogle, 'Pop. Sci. Rev.,' London, viii, 1869; Darwin, 'Cross- and Self-Fertilization,' p. 427; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 262; Correns, op. cit.; Knuth, 'Bloemenbiol. Bijdragen.')—The lower anther-lobes of the large yellow flower of this species are quite sterile and completely retracted into the corolla-tube. The latter is so long that only humble-bees with a proboscis about 14 mm. long can suck all the nectar legitimately. The corolla-tube (in plants from the Kiel Botanic Garden) is 18–19 mm. long, but widens out at the entrance for a depth of 4–5 mm., so that a humble-bee can insert its entire head.

Correns says that S. glutinosa may be distinguished from S. pratensis and related species by the fact that the lower half of the connective no longer performs the additional function of a nectar-cover, a special organ of this kind being present, while the connective-plate presents its edge and not its surface to visitors. The unions between the two anthers and the two sterile connective surfaces are very variable. The membranes of the joint are here also of the greatest extensibility; in different flowers the joint resists torsion to a varying degree.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Sprengel, humble-bees. Ogle was the first to notice flowers perforated by humble-bees (of undetermined sp.). Herm. Müller (canton Graubünden) and Knuth (between Interlaken and Grindelwald) noticed the humble-bee Bombus mastrucatus *Gerst.* as a nectar-thief; it perforated the upper side of the corolla-tube, and sucked nectar through the holes thus made. Frey-Gessner made similar observations. Knuth (Kiel Botanic Garden), 2 humble-bees, skg. legitimately—Bombus agrorum *F.* ♀, and B. hortorum *L.* ♀. Gerstäcker (Kreuth), 2 bees—Bombus mastrucatus *Gerst.* ♀ and ☿, and Psithyrus vestalis *Fourcr.* Schletterer (Pola), 3 bees—1. Bombus argillaceus *Scop.*; 2. B. derhamellus *K.*; 3. Xylocopa violacea *L.* von Dalla Torre (Pola), the humble-bee B. mastrucatus *Gerst.*

Loew (Ber. D. bot. Ges., Berlin, vi, 1886, pp. 128–9) also observed the humble-bee Bombus hortorum *L.* in the Berlin Botanic Garden; but pollination does not seem to have been effected regularly, for Loew noticed that in autumn (in the middle of September) a ♂ of this species visited in succession about 50 flowers on the same stock, but did not once touch the tip of the style with its thickly-dusted back. In the majority of flowers the connective-plates were separate.

Loew states that the sticky glandular hairs of the flower undoubtedly form a protection against unbidden guests, for he found flies and ants sticking to the calyx in several instances.

2238. S. Sclarea L. (Hildebrand, Jahrb. wiss. Bot., Leipzig, vi, 1886; Herm. Müller, 'Fertilisation,' p. 479; Correns, op. cit.; Schulz, 'Beiträge.')—The flower mechanism of this species essentially agrees with that of S. pratensis, but Correns found a firmer union between the filament and connective; the membrane of those epidermal cells of the joint nearest the filament being considerably thicker than that of the cells adjoining the connective. The spoon-shaped plate formed by the lower ends of the connectives does not completely close the entrance to the nectar, and there is therefore a reduced nectar-cover in the corolla-tube in the form of a small fringed scale. Schulz observed female stocks as well as those bearing protandrous hermaphrodite flowers.

Visitors.—Morawitz observed the following 5 bees in the Caucasus.—

1. Bombus haematurus *Kriechb.*; 2. Eucera similis *Lep.*; 3. Eucera spectabilis *Mor.*; 4. Podalirius raddei *Mor.*; 5. P. tarsatus *Spin.*

2239. S. aethiopica (= S. Aethiopis *L.*?); **2240. S. argentea** L.; **2241. S. virgata** Ait.; **2242. S. pendula** Vahl.—These species agree (Hildebrand, op. cit.) as to their flower mechanism with S. pratensis.

Visitors.—Loew (Berlin Botanic Garden) saw the bee Megachile fasciata *Sm.* ♂, skg., on S. argentea, and the honey-bee, skg., on S. virgata.

2243. S. nutans L.—Hildebrand (op. cit.) and Correns (op. cit.) state that this species differs from S. pratensis in possessing perfectly upright straight connectives, the stamens therefore projecting much less. As the flowers grow in pendulous racemes and their position is consequently reversed, visitors alight on the upper lip, and are thus dusted on their lower sides by the slightly projecting anthers.

2244. S. splendens Ker-Gawl.—Hildebrand (op. cit.) says that in this species the lower halves of the connectives are not bent forward, but are flat plates almost entirely fused with each other.

2245. S. splendens Sellow (= S. colorans *Hort.*).—W. Trelease says that this Brazilian species is pollinated by humming-birds. The lower lip, which in our native species serves as an alighting-platform for humble-bees, is therefore small and undeveloped. The corolla is about 6 cm. long and conceals abundant nectar in its base. It is scarlet, as is also the calyx, and placed almost horizontally; its tube is slightly compressed laterally. The style with the stigma projects from the corolla as in our species. The filaments are inserted at the point of separation of the upper and lower lips. The connectives form, as in humble-bee flower species, a lever with arms of equal length; the front end of this lever bears the fertile anther-lobes, while the other lies on the inner surface of the corolla, and is devoid of lobes. Bees and humble-bees are too small for this flower mechanism, their proboscides being too short to reach the nectar; butterflies are too weak to set the lever apparatus in motion; powerful moths might do so, but as the colour of the flowers makes them inconspicuous at night this is improbable. It must, therefore, be assumed that humming-birds effect pollination. Fritz Müller has, in fact, seen humming-birds visiting the scarlet-red species of Salvia in South Brazil; when these visitors sucked nectar, pollen was sprinkled on the front of their heads, to be transferred to the stigmas of flowers in the second (female) stage.

2246. S. Grahami Benth.—Hildebrand (op. cit.) says that this species possesses homogamous flowers, in which the style scarcely projects beyond the anthers.

2247. S. lanceolata Brouss.—The flower mechanism of this species is the same as that of S. Grahami, and Hildebrand says that the lower stigmatic lobe is situated between the anthers, so that automatic self-pollination takes place.

2248. S. hirsuta Jacq. This species also (Hildebrand, op. cit.) is capable of automatic self-pollination, the greatly enlarged lower stigmatic lobe bending so far

back as to touch both anthers. According to Hildebrand's investigations autogamy is always effective.

2249. S. officinalis L. (Sprengel, 'Entd. Geh.,' pp. 62–4; Hildebrand, op. cit.; Delpino, 'Ult. oss.'; Herm. Müller, 'Fertilisation,' pp. 480–1, 'Weit. Beob.' III, pp. 55–6; Ogle, Pop. Sci. Rev., London, viii, 1869; Knuth, 'Bloemenbiol. Bijdragen,' 'Grundriss d. Blütenbiol.,' pp. 83–4; Kirchner, 'Flora v. Stuttgart,' pp. 618–19; Correns, op. cit.; Schulz, 'Beiträge,' II, pp. 195 and 1917.)—The violet-coloured, protandrous flowers of this species are marked on the lower lip with dark-violet and whitish streaks which serve as nectar-guides. A ring of hairs in the corolla-tube immediately above the nectar acts as a nectar-cover.

The flower mechanism differs from that of S. pratensis in the following particulars. The upper lip is short, but so broad that it protects the mouth of the flower from rain. The two connective-joints are much shorter than in S. pratensis. The lower anther-lobes generally still contain some pollen, but they are always much smaller than the upper ones, and contain only a quarter or, at the most, half as many pollen-grains as the latter; they are seldom completely vestigial. The lower limb of the connective is therefore not modified into a plate closing up the flower-entrance, but is kidney-shaped, almost like the upper one, only slightly smaller. The hammer mechanism of this species may therefore be considered less complete than that of S. pratensis. Both lobes of the anthers are situated in the mouth of the flower, the upper projecting slightly more forward than the lower. They lie so close together that both are always turned downwards simultaneously, and also resume their original positions together. A bee visitor can easily reach between the diverging filaments to the nectar. In doing so it must first strike against both lower anther-lobes with its head and receive pollen on its back from the upper lobes, which are now depressed. In young flowers the stigma with its still apposed branches projects but little from the upper lip, but in older flowers it hangs down in the entrance of the flower in such a position that a bee visitor must deposit pollen on the diverging stigmatic branches.

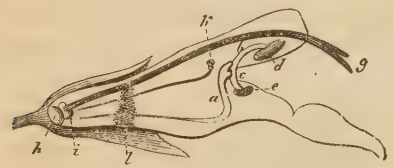


FIG. 330. *Salvia officinalis*, *L.* (after Herm. Müller). Flower after removal of the right half of the calyx and corolla, seen from the right side. *a*, filament; *b c*, connective; *d e*, upper and lower anther-lobes; *g*, stigma; *h*, nectary; *i*, ovary; *k*, vestigial anther; *l*, nectar-cover.

Schulz observed purely female stocks at Bozen. He also sometimes found the flowers perforated by Bombus terrester *L.*

VISITORS.—Herm. Müller (H. M.) Borgstette (B.) and Buddeberg (Budd.) observed the following.—

A. Diptera. *Syrphidae*: 1. Melanostoma ambigua *Fall.*, po-dvg. (H. M.). **B. Hymenoptera.** *Apidae*: 2. Anthidium manicatum *L.* ♀, skg. (H. M.); 3. Anthophora aestivalis *Pz.* ♀, do. (H. M.); 4. Bombus agrorum *L.* ☿, do. (H. M., Strasburg, B.); 5. B. hortorum *L.* ♀, do. (H. M., Thuringia); 6. B. pratorum *L.* ♀ and ☿, do. (H. M., Thuringia); 7. B. pomorum *Pz.* ♀, skg. and po-cltg. (H. M., Thuringia); 8. B. rajellus *K.* ♀, do. (H. M., Thuringia); 9. B. sylvarum *L.* ♀, skg. (H. M.); 10. Chelostoma campanularum *K.* ♀, skg. and po-cltg. (H. M., Thuringia); 11. C. nigricorne *Nyl.* ♂, skg. (H. M., Thuringia, Budd.); 12. Eucera longicornis *L.* ♀ and ♂, do. (H. M., Thuringia, B.); 13. Halictus sexnotatus *K.* ♀, po-cltg. (H. M.)

14. Osmia aenea *L.* ♀, skg. (B.); ♀ and ♂, very common, skg. and po-cltg. (H. M., Strasburg); 15. O. caementaria *Gerst.* ♂, skg. (Budd.); 16. O. rufa *L.* ♀, do. (Budd.); 17. Prosopis communis *Nyl.* (B.); 18. Psithyrus barbutellus *K.* ♀, skg. (H. M.); 19. Xylocopa violacea *L.* ♂, freq., skg. (H. M., Strasburg) **C. Lepidoptera.** 20. A butterfly as an unbidden guest.

The following were recorded by the observers, and for the localities stated.—

Sprengel and Hildebrand, the honey-bee. Knuth (Kiel Ober-Realschule Garden).—**A. Hymenoptera.** *Apidae*: all skg.: 1. Apis mellifica *L.* ☿; 2. Bombus hortorum *L.* ♀ and ☿; 3. B. lapidarius *L.* ♀, ☿ and ♂; all three with a streak of pollen on the back when leaving the flowers. **B. Diptera.** *Syrphidae*: 4. Syrphus pyrasti *L.*, po-dvg. **C. Lepidoptera.** *Rhopalocera*: 5. Pieris napi *L.* skg. Loew (Berlin Botanic Garden), 2 bees—Anthidium manicatum *L.* ♀, skg., and Apis mellifica *L.* ☿, steadily skg. Rössler (Wiesbaden), the Tineid moth Coleophora ornatipennella *Hb.* Schletterer, for Tyrol (T.) and Pola (P.), 6 bees—1. Andrena limbata *Ev.*; 2. Bombus argillaceus *Scop.* (T., P.); 3. B. terrester *L.* (T.); 4. Eucera longicornis *L.* (T.); 5. E. (Macrocera) ruficollis *Brull.*; 6. Podalirius retusus *L.*, var. meridionalis *Pér.* von Dalla Torre (a garden in the Tyrol), the bee Eucera longicornis *L.* ♂.

2250. S. Roemeriana Scheele (= S. porphyrantha *Dcne.*).—T. H. Corry says that the flower mechanism of this species resembles that of S. officinalis. The lower anther-lobes contain a small quantity of pollen.

2251. S. triangularis Thunb.—Hildebrand (op. cit.) states that flowers of this species possess immovable connectives, stretching almost straight back and bearing a fertile anther-lobe at each end. As the two anterior ones are situated somewhat in front of the entrance to the flower, and the two posterior ones rather behind it, the bee, on entering the flower, first brushes against the former with its back, and then the latter with its sides. In the second stage of anthesis the stigma projects beyond the anterior anther-lobes, and is therefore first touched by insects.

2252. S. tubiflora Sm.—Hildebrand (op. cit.) states that in this species the posterior anther-lobes are sterile, and modified into an elongated plate applied to the upper lip.

2253. S. nubia Ait.—Hildebrand (op. cit.) and Correns (op. cit.) say that the flower mechanism of this species agrees almost entirely with that of S. officinalis; but the two lower limbs of the connectives, though close together, are not united, so that each can be separately twisted round.

2254. S. verticillata L. (Sprengel, 'Entd. Geh.,' p. 64; Hildebrand, op. cit.; Delpino, 'Sugli appar. d. fecondaz. nelle piante autocarp.,' pp. 33–4; Herm. Müller, 'Fertilisation,' p. 482, 'Weit. Beob.,' III, p. 56, 'Alpenblumen,' p. 317; Schulz, 'Beiträge,' I, pp. 80–1, II, pp. 129–30; Kirchner, 'Flora v. Stuttgart,' p. 617; Loew, 'Blütenbiol. Floristik,' p. 395; Correns, op. cit.)—The bright violet flowers of this species are partly protandrous hermaphrodite, and partly gynodioecious or gynomonoecious. Their size is very variable, but definite classification into groups is impossible. The upper lip of the corolla stretches straight forward, narrowed and constricted below, and so joined to the tube that it can be bent back, serving as a movable hood to the anthers. The connectives, however, are immovably united to the filaments. The insect visitor strikes against and pushes back the upper lip, so that the two upper anther-lobes are exposed and touched. When the pressure caused by the visitor is removed, the parts generally resume their

original position. The lower connective limb is much reduced; it is merely a little (0·7 mm. long) tooth directed downwards. The two upper limbs of the connectives, bearing fertile anther-lobes, lie close to each other on the upper lip in the line of the filaments. The style is at first bent down on to the lower lip, so that the stigma lies in the entrance of the flower. At first it is short and the stigmatic branches are apposed. The style then elongates and moves somewhat upwards, while the stigmatic branches diverge, so that they stand before the mouth of the flower. Nectar-seeking bees press back the upper lip of the corolla, and are dusted with pollen in young flowers, which they transfer to the stigmas of older ones.

Schulz says that the corolla reaches 10–15 mm. in length in hermaphrodite flowers, but only 5–9 mm. in female ones. The lower whorls of the inflorescence are generally entirely hermaphrodite, and the upper ones entirely female; or there are single lateral flowers of the unilateral half-whorl in the lower part of the inflorescence which are female, or single lateral flowers in all the half-whorls which may be female. In female flowers the connectives and filaments have quite disappeared, so that the sterile anthers are sessile on the corolla. Schulz observed perforation.

Visitors.—Buddeberg observed the following bees in Nassau, all skg.—

1. Apis mellifica *L.* ☿, in great numbers; 2. Bombus pratorum *L.* ♀; 3. B. sylvarum *L.* ♀ and ☿; 4. B. tristis *Seidl.* ♀; 5. Coelioxys rufescens *Lep.* ♀ and ♂; 6. Halictus albipes *F.* ♂ and ♀, freq.; 7. H. leucopus *K.* ♀; 8. H. longulus *Sm.* ♂, freq.; 9. H. nitidiusculus *K.* ♀; 10. H. nitidus *Schenck* ♀; 11. H. quadristrigatus *Ltr.* ♀; 12. H. sexnotatus *K.* ♀; 13. H. xanthopus *K.* ♀, freq.; 14. Osmia adunca *Ltr.* ♂; 15. O. aenea *L.* ♀; 16. O. caementaria *Gerst.* ♀; 17. Prosopis armillata *Nyl.* ♂; 18. Saropoda bimaculata *Pz.* ♂.

The following were recorded by the observers, and for the localities stated.—

Loew (Steiermark), the humble-bee Bombus hortorum *L.*, skg. Gerstäcker (Kreuth), 4 bees—1. Bombus jonellus *K.*; 2. B. mucidus *Gerst.*; 3. B. subterraneus *L.*; 4. Psithyrus vestalis *Fourcr.* Schletterer (Tyrol), 5 bees—1. Bombus jonellus *K.*; 2. B. mesomelas *Gerst.*; 3. B. subterraneus *L.*; 4. Eriades florisomnis *L.*; 5. Halictus leucozonius *Schr.* von Dalla Torre (Tyrol), the bee Anthophora furcata *Pz.* ♀.

2255. S. Verbenaca L.—Willis (J. Linn. Soc. Bot., London, xxx, 1894) says that this species is cleistogamous in England.

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Diptera. *Syrphidae*: 1. Melithreptus scriptus *L.*, settling on the flowers; 2. Syritta pipiens *L.*, do. **B. Hymenoptera.** *Apidae*: 3. Anthidium manicatum *L.* ♀, skg.; 4. Apis mellifica *L.* ☿, steadily skg. **C. Lepidoptera.** *Rhopalocera*: 5. Pieris brassicae *L.*, skg.

2256. S. clandestina L. (perhaps only a variety of the last species).—

Visitors.—Schletterer observed 2 long-tongued bees at Pola—Bombus argillaceus *Scop.*, and Podalirius crinipes *Sm.*

2257. S. Regeliana Trautv. (Correns, op. cit.)—The white flowers of this species possess a mechanism very similar to that of S. verticillata, but the connective is smaller, and the sterile limb relatively shorter and blunter.

2258. S. Horminum L.—Correns (op. cit.) states that in this species the two

sterile limbs of the connectives are fused for their entire length. A very complete barrier to the interior of the flower is thus formed. This union of the two adjacent edges of the sterile limbs is effected by papillae of varying length, and is so firm that it is easier to tear the joint than to separate the two connectives. The lever mechanism with its torsion-joint resembles the corresponding arrangement in S. pratensis, but is simpler and firmer.

2259. S. hispanica L., and **2260. S. tilifolia** L.—Correns states that the flower mechanisms of these species resemble that of S. Horminum.

2261. S. austriaca Jacq. (Hildebrand, op. cit.; Delpino, op. cit.; Schulz, 'Beiträge.')—Hildebrand says that in the protandrous hermaphrodite flowers of this species the anther-lobes are far apart, and project from the upper lip. The upper limbs of the connectives are situated on either side of this lip, and bend towards each other when the connective-plate is touched in such a manner that the anther-lobes come into contact in front of the entrance of the flower. Later on the stigma occupies this position, owing to a curving of the style. Schulz states that purely female stocks occur as well as hermaphrodite ones.

Visitors.—Hildebrand supposes these to be moths.

2262. S. patens Cav.—In this species also (Hildebrand, op. cit.) the anthers project entirely or partly from the upper lip. The style is so placed between the upper limbs of the connectives that it is obliged to share their torsion. The stigma, projecting beyond the anther-lobes, must therefore first touch a visitor's back, by which means cross-pollination is ensured. Ogle says that the back of an insect alighting on the lower lip is at first touched in two places, i. e. by the stigma dorsally, and by the anther-lobes dorso-laterally. If the insect creeps further into the flower, the stigma and anthers slide along towards the tip of the abdomen, thus preventing self-pollination. When a second flower is visited the stigma will come into contact with one of the pollen-covered areas on the insect's body. Self-pollination can be effected in flowers with styles too short for crossing. Ogle states that nectar is secreted by glandular hairs situated above the lowest part of the corolla-tube.

2263. S. carduacea Benth. (Hildebrand, Ber. D. bot. Ges., Berlin, i, 1883.)—The upper lip of flowers belonging to this species is not galeate, but flattened out. The two filaments are very short, and their anther-lobes are respectively borne on the short upper and long, widely exserted lower limbs of the connectives. Those in the latter position dehisce laterally, so that insect visitors are dusted with pollen on each side. In the second stage of anthesis the two stigmatic branches occupy the position taken up by the anther-lobes in the first. They are therefore situated right and left, and not above and below as usual.

2264. S. cleistogama De Bary et Paul.—Ascherson (Bot. Ztg., Leipzig, xxx, 1872) says that the plants brought to Halle from Africa bore only cleistogamous flowers during the first five years, but chasmogamous ones subsequently.

2265. S. Bertolonii Vis.—

Visitors.—Schletterer observed the following bees at Pola.—

1. Anthidium manicatum *L.*; 2. A. septemdentatum *Ltr.*; 3. Andrena flavipes *Pz.*; 4. A. limbata *Ev.*; 5. A. parvula *K.*; 6. Bombus argillaceus *Scop.*; 7. B.

terrester *L.*; 8. Eucera hispana *Lep.*; 9. E. interrupta *Baer.*; 10. E. longicornis *L.*; 11. E. ruficollis *Brull.*; 12. Megachile argentata *F.*; 13. M. manicata *Gir.*; 14. M. muraria *Retz.*; 15. Nomada imperialis *Schmiedekn.*; 16. Osmia aurulenta *Pz.*; 17. O. pallicornis *Friese*; 18. O. rufohirta *Ltr.*; 19. Podalirius crinipes *Sm.*; 20. P. dufourii *Lep.*; 21. P. retusus *L.*, var. meridionalis *Pér.*

Loew observed the following in the Berlin Botanic Garden.—

1. Bombus agrorum *F.* ☿, po-cltg.; 2. B. hortorum *L.* ♀ and ☿, steadily skg.; 3. Megachile centuncularis *L.* ♀, skg.; M. fasciata *Sm.* ♀, do.

2266. S. Tenore Spr. (= S. pratensis *L.*, according to the *Index Kewensis*), and **2267. S. coccinea** Juss.—Darwin describes these species as self-sterile.

2268. S. Baumgarteni Griseb. (= S. pratensis *L.*, according to the *Index Kewensis*).—

Visitors.—Loew observed the following bees in the Berlin Botanic Garden.—

1. Anthidium manicatum *L.* ♀, skg.; 2. Bombus hortorum *L.* ♀, do., covering its back thickly with pollen; 3. Megachile fasciata *Sm.* ♂, skg.

2269. S. controversa Tenore.—

Visitors.—Loew observed the humble-bee Bombus hortorum *L.* ♀, skg., in the Berlin Botanic Garden.

2270. S. lanata Mich.—

Visitors.—Loew (Berlin Botanic Garden) observed 2 bees—Anthidium manicatum *L.* ♀, skg., and Bombus agrorum *F.* ☿, steadily skg.

2271. S. sclaraeoides Brot.—

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Diptera. *Syrphidae*: 1. Pipiza chalybeata *Mg.*, on the flowers. **B. Hymenoptera.** *Apidae*: 2. Bombus hortorum *L.* ♂, skg. **C. Lepidoptera.** *Rhopalocera*: 3. Rhodocera rhamni *L.*, skg.; 4. Pieris brassicae *L.*, going steadily from flower to flower, and skg.

706. Monarda L.

2272. M. ciliata (?).—The flower mechanism of this species has been very fully described by Errera and Gevaert (Bull. Soc. roy. bot. Belge, Bruxelles, xvii, 1878, pp. 128–32), and shown to be adapted for crossing by hawk-moths.

2273. M. didyma L.—

Visitors.—Hermann Müller saw the noctuid moth Plusia gamma *L.*, in the evening ('Weit. Beob.,' III, p. 55), and Loew (Berlin Botanic Garden) observed 2 bees—Apis mellifica *L.* ☿, skg. through holes made by humble-bees, and Bombus terrester *L.* ☿, perforating the base of the corolla-tube.

2274. M. fistulosa L.—Willis (J. Linn. Soc., Bot., London, xxx, 1895) describes this species as bearing protandrous flowers, though these are smaller than those of M. didyma.

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Hymenoptera. *Apidae*: 1. Bombus terrester *L.* ☿, appearing to suck legitimately; 2. Halictus sexnotatus *K.* ♀, vainly skg.; 3. Psithyrus vestalis *Fourcr.* ♂, skg. **B. Lepidoptera.** *Rhopalocera*: 4. Pieris brassicae *L.*, skg. On the var. *albicans* the humble-bee Bombus terrester *L.* ♂, skg. On the var. *mollis*.—

A. Hymenoptera. *Apidae*: 1. Apis mellifica *L.* ☿, trying to suck; 2. Bombus terrester *L.* ♂, skg.; 3. Psithyrus vestalis *Fourcr.* ♂, do. **B. Lepidoptera.** *Rhopalocera*: 4. Pieris brassicae *L.*; 5. Vanessa urticae *L.*; both skg. On the var. *purpurea* 3 bees—1. Bombus agrorum *F.* ♂, skg. legitimately; 2. B. terrester *L.* ♂, do.; 3. Psithyrus vestalis *Fourcr.* ♂, skg.

707. Ramona.

2275. R. polystachya (Benth.) Greene. (Rippa, Boll. Soc. nat., Napoli, xv, 1902, pp. 51–3.)—Rippa examined plants of this species (indigenous to Colorado) cultivated at Naples. As compared with the related genus Salvia there is a marked reduction of the lower lip, and the anterior limbs of the connectives are vestigial. Hairs within the corolla-tube serve as a nectar-cover, and the large lower lip is hispid. A bee forcing its way into the flower gets irregularly dusted with pollen laterally, and forces the style strongly to the side so that autogamy takes place. The lower lip subsequently erects itself, so that a visitor is obliged to depress it in order to get at the nectar, and in doing so describes a lateral movement by which any pollen it brings can be deposited on the stigma. Allusion must also be made to the presence of sticky drops on the surfaces of the anthers and sides of the connexions (according to Solla, referred to op. cit.).

708. Origanum Tourn.

Protandrous hermaphrodite flowers; with nectar secreted by the large base of the ovary, concealed in the glabrous bottom of the corolla, and protected from rain by a ring of hairs. Often gynodioecious and gynomonoecious.

2276. O. vulgare L. (Darwin, 'Cross- and Self-fertilisation,' p. 94; Herm. Müller, 'Fertilisation,' pp. 475–6, 'Weit. Beob.,' III, pp. 57–8, 'Alpenblumen,' p. 322; Kirchner, 'Flora v. Stuttgart,' p. 611; Schulz, 'Beiträge'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. I, II, p. 298; Knuth, 'Bloemenbiol. Bijdragen.')—The hermaphrodite flowers of this species are large (about 7 mm. long) and protandrous, the female considerably smaller (4–5 mm. long). Schulz says that, sporadically, the latter are as numerous as the former. Willis found about 6 % female flowers near Cambridge. Kerner states that these open a week or more before the hermaphrodite ones, and he therefore describes them as protogynous. He adds that in a circuit of some km. no pollen is available for the stocks which flower first. The dull-purple flowers grow in dense half-whorls, crowded into cymose spikes; this makes them very conspicuous, and they are much visited by insects. Stamens and style project from the flower, but self-pollination is prevented by protandry. In female flowers the anthers are often completely absent. Visitors belong to very various groups. They may be insects with quite a short proboscis, as the corolla-tube is fairly wide and very short (in hermaphrodites 4–5 mm., in females 3–4 mm.). Various parts of their bodies are dusted with pollen, and touch the stigma irregularly with first one part and then another, thus effecting crossing.

Visitors.—Herm. Müller (H. M.) and Buddeberg give the following list for Central Germany.—

A. Diptera. (*a*) *Bombyliidae*: 1. Bombylius canescens *Mik.* (Budd.). (*b*) *Conopidae*: 2. Myopa polystigma *Rond.* (H. M.); 3. M. variegata *Mg.* (H. M.); 4. Physocephala rufipes *F.* (Budd.); 5. Sicus ferrugineus *L.* (H. M.). (*c*) *Empidae*: 6. Empis livida *L.*, very common (H. M.); 7. E. rustica *Fall.*, do. (H. M.). (*d*) *Muscidae*: all skg.: 8. Ocyptera brassicaria *F.*, very common (H. M.); 9. O. cylindrica *F.*, do. (H. M.); 10. Prosena siberita *F.*, freq. (H. M.). (*e*) *Syrphidae*: 11. Ascia podagrica *F.*, freq., po-dvg. (H. M.); 12. Eristalis arbustorum *L.*, freq., skg. and po-dvg. (H. M.); 13. E. horticola *Deg.* (Budd.); 14. E. nemorum *L.*, skg. and po-dvg. (H. M.); 15. E. pertinax *Scop.* (Budd.); 16. E. tenax *L.* (H. M., Budd.); 17. Helophilus floreus *L.*, skg. and po-dvg. (Budd.); 18. H. pendulus *L.*, skg. (H. M.); 19. Syrphus pyrastri *L.*, skg. and po-dvg. (Budd.); 20. Volucella bombylans *L.*, do. (Budd); 21. V. inanis *L.*, do. (H. M.); 22. V. pellucens *L.*, do. (H. M.); 23. V. plumata *L.*, do. (Budd.). **B. Hymenoptera.** *Apidae*: 24. Apis mellifica *L.* ☿, in large numbers, skg. (H. M.); 25. Bombus terrester *L.* ♂ and ♀, skg. (H. M.); 26. Coelioxys rufescens *Lep.* ♂, skg. (Budd.); 27. Epeolus variegatus *L.* ♂, do. (Budd.); 28. Halictus albipes *F.* ♂, very numerous, skg. (H. M.); 29. H. cylindricus *F.* ♂, do. (H. M., Budd.); 30. H. flavipes *F.* ♀ and ♂, do. (H. M.); 31. H. nitidus *Schenck* ♂, skg. (H. M.); 32. H. quadricinctus *F.*, do. (Budd.); 33. H. rubicundus *Sm.* ♀, do. (H. M.); 34. H. smeathmanellus *K.* ♂ and ♀, do. (Budd.); 35. Nomada jacobaeae *Pz.* ♂ and ♀, freq., skg. (H. M.); 36. Osmia aurulenta *Pz.* ♀, do. (H. M.); 37. Saropoda bimaculata *Pz.* ♀ and ♂, skg. (Budd.). **C. Lepidoptera.** *Rhopalocera*: 38. Argynnis paphia *L.*, freq., skg. (H. M.); 39. Epinephele hyperanthus *L.*, skg. (H. M.); 40. E. janira *L.*, do. (H. M., Budd.); 41. Lycaena sp., do. (H. M.); 42. Pieris napi *L.*, do. (H. M.); 43. Vanessa urticae *L.*, do. (H. M.).

Burkill and Willis observed the following at Cambridge ('Fls. and Insects in Gt. Britain,' Part I).—

A. Coleoptera. *Nitidulidae*: 1. Meligethes aeneus *F.*, po-dvg. **B. Diptera.** (*a*) *Muscidae*: 2. Anthomyia sp.; 3. Homalomyia canicularis *L.*; 4. Scatophaga stercoraria *L.*; 5. Siphona geniculata *Deg.* (*b*) *Syrphidae*: 6. Eristalis horticola *Deg.*; 7. E. pertinax *Scop.*; 8. E. tenax *L.*; 9. Myiatropa florea *L.*; 10. Syrphus balteatus *Deg.*; 11. S. ribesii *L.*; 12. S. vitripennis *Mg.* **C. Hemiptera.** 13. Anthocoris sp.; 14. Calocoris bipunctatus *F.* **D. Hymenoptera.** (*a*) *Apidae*: 15. Andrena sp., skg.; 16. Apis mellifica *L.*, freq., skg.; 17. Bombus hortorum *L.*, do.; 18. B. pratorum *L.*, do.; 19. B. terrester *L.*, do; 20. Halictus minutissimus *K.*, skg.; 21. Psithyrus quadricolor *Lep.*, do.; 22. P. vestalis *Fourcr.*, do. (*b*) *Vespidae*: 23. Odynerus sp., skg. **E. Lepidoptera.** (*a*) *Rhopalocera*: 24. Pieris brassicae *L.*, freq., skg.; 25. P. napi *L.*, do.; 26. P. rapae *L.*, do.; 27. Polyommatus phlaeas *L.*, do.; 28. Vanessa urticae *L.*, do. (*b*) *Pyralidae*: 29. Botys purpuralis *L.*, var. ostrinalis *Hb.*, skg.

The following were recorded by the observers, and for the localities stated.—

Knuth (Schleswig-Holstein), the honey-bee, skg., 2 humble-bees, skg. (Bombus terrester *L.*, and B. lapidarius *L.*), 4 po-dvg. or skg. hover-flies (1. Eristalis tenax *L.*; 2. E. nemorum *L.*; 3. Syrphus balteatus *Deg.*; 4. Melithreptus taeniatus *Mg.*), and 2 skg. butterflies (Pieris napi *L.*, and Vanessa urticae *L.*): (Rügen), a butterfly (Epinephele janira *L.*) and a hawk-moth (Zygaena sp.). Alfken (Bremen), the humble-bee Bombus sylvarum *L.* ♂. Schenck (Nassau), 2 bees—Coelioxys conoidea *Ill.*, and Halictus tetrazonius *Klg.* (= H. quadricinctus *K.*). Rössler (Wiesbaden), 2 moths—Callimorpha hera *L.*, and Mesophleps silacellus *Hb.* Herm. Müller (Alps), 2 humble-bees, a Lepidopterid, and a hover-fly. MacLeod (Pyrenees), 6 Hymenoptera, 10 Lepidoptera, 3 Syrphids, and 2 Muscids (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 325). Frey (Switzerland), the moth Callimorpha hera *L.* Schletterer and von Dalla Torre (Tyrol), 5 bees—Anthidium septemdentatum *Ltr.*; 2. Bombus

lapidarius *L.*; 3. B. soroënsis *F.*; 4. B. terrester *L.*; 5. Podalirius vulpinus *Pz.* von Dalla Torra (Tyrol), the Chrysidid Chrysis analis *Spin.* Gerstäcker (Kreuth), the parasitic humble-bee Psithyrus vestalis *Fourcr.*, numerous. Schmiedeknecht (Marseilles, *teste* Jullian), the parasitic bee Nomada nobilis *H.-Sch.* Loew (Berlin Botanic Garden).—**A. Diptera.** (*a*) *Muscidae*: 1. Echinomyia fera *L.* (*b*) *Syrphidae*: 2. Eristalis tenax *L.*; 3. Syritta pipiens *L.* **B. Hymenoptera.** *Apidae*: 4. Bombus terrester *L.* ♀, skg.; 5. Halictus cylindricus *F.* ♂, do.; 6. H. rubicundus *Chr.* ♀, do. **C. Lepidoptera.** *Rhopalocera*: 7. Lycaena adonis *S. V.*, skg.; 8. L. alexis *S. V.*, do.

2277. O. Majorana L. (Kirchner, 'Beiträge,' pp. 54–5; Knuth, 'Bloemenbiol. Bijdragen.')—Such cultivated plants of this species as have been observed were protandrous. The small white flowers do not protrude far beyond the green bracts, which are arranged in four rows. Only the corolla-limb and the mouth of the flower are visible, the corolla-tube, which is 4 mm. long and funnel-shaped, being hidden between the bracts. The stamens project beyond the four almost equal corolla-tubes, the two longer ones diverging laterally. When the white anthers dehisce, the style with immature stigma is still hidden in the corolla-tube. After the anthers have shrivelled, the style elongates so far that it projects 2 mm. beyond the corolla, and presents its now diverging stigmatic branches to visitors.

Visitors.—Knuth observed the honey-bee, and the humble-bee Bombus lapidarius *L.*, both skg.

709. Satureia L.

As Origanum.

2278. S. hortensis L. (Darwin, 'Different Forms of Flowers,' pp. 303–4; Herm. Müller, 'Weit. Beob.,' III, p. 56; Schulz, 'Beiträge,' II, p. 196; Breitenbach, Kosmos, Stuttgart, xiv, 1884.)—The flowers of this species are lilac or white in colour, with red dots in the throat serving as nectar-guides. Breitenbach states that there are three kinds of flowers, large hermaphrodite, small female ones, and some with two reduced anthers. Darwin says that the plant is gynodioecious, and that the female flowers are more fertile than the protandrous hermaphrodite ones.

Schulz found 15–20 % of female flowers in plants cultivated at Halle.

Visitors.—Herm. Müller observed the following.—

A. Diptera. *Syrphidae*: 1. Eristalis sepulcralis *L.*, skg.; 2. Helophilus floreus *L.*, do.; 3. Syritta pipiens *L.*, very numerous, skg. **B. Hymenoptera.** *Apidae*: 4. Apis mellifica *L.* ☿, in large numbers, persistently skg. **C. Lepidoptera.** *Rhopalocera*: 5. Pieris rapae *L.*, skg.

2279. S. montana L.—

Visitors.—The following were recorded by the observers, and for the localities stated.—

Schletterer (Pola).—**Hymenoptera.** (*a*) *Apidae*: 1. Bombus argillaceus *Scop.*, freq., Sept. to Oct.; 2. B. terrester *L.*, freq., Sept. to Nov.; 3. Halictus calceatus *Scop.* (*b*) *Ichneumonidae*: 4. Platylabus pedatorius *Gr.*, a ♂. (*c*) *Scoliidae*: 5. Scolia hirta *Schr.* (*d*) *Vespidae*: 6. Polistes gallica *L.* MacLeod (Pyrenees), 4 humble-bees and 3 Lepidoptera (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 327).

710. **Thymus** Tourn.

Species of this genus may be trioecious, but otherwise agree with those of Origanum.

2280. T. Serpyllum L. (Sprengel, 'Entd. Geh.,' p. 311; Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.,' p. 26; Herm. Müller, 'Fertilisation,' pp. 472–5, 'Weit. Beob.,' III, pp. 56–7, 'Alpenblumen,' p. 322; Warming, 'Bestövningsmaade,' pp. 10–13; Knuth, 'Blütenbiol. Beob. a. d. Ins. Rügen,' 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 117, 165, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 234; Kirchner, 'Flora v. Stuttgart,' p. 612.)—Besides protandrous hermaphrodite flowers there are smaller female ones in this species; male flowers, however, are rare. The bright purple, rarely white blossoms are very fragrant, and the nectar (according to Hermann Müller) is of a spicy flavour. The capitate inflorescences are often so close together that they form (e. g. in the North Frisian Islands) large violet cushions on the moor-

FIG. 331. *Thymus*, *L.* (after Herm. Müller). (1)-(3) *T. Serpyllum*, *L.* (1) Hermaphrodite flower in the first (male) stage. (2) Do., in the second (female) stage. (3) Female flower. (4)-(6) *T. vulgaris*, *L.* (4) Female flower. (5) Pistil of a hermaphrodite flower in the first stage. (6) Do., in the second stage. *a*, vestigial anther; *n*, nectary; *ov*, ovary (× 7).

land and beside its paths. This renders them extremely conspicuous, and they are therefore much visited by insects. The flower mechanism is essentially the same as that of Origanum vulgare. The stamens and style project freely from the corolla; in hermaphrodite flowers the stamens generally project beyond the style, which, however, elongates later on, and stigmatic branches diverge as soon as they are above the anthers. Automatic self-pollination is therefore impossible.

Hitherto only female and hermaphrodite flowers on different stocks have been observed in Germany. Delpino found the species to be trioecious near Florence. In England Ogle observed transitions to purely male flowers, in addition to the

hermaphrodite and female ones. Möwes (Bot. Jaarb., Leipzig, iv, 1883) often found the flowers with stamens entirely or partly reduced.

Visitors.—Knuth observed the following.—

I. Schleswig-Holstein.—**A. Coleoptera.** *Carabidae*: 1. Carabus cancellatus *L.*, dvg. the flowers. **B. Diptera.** (*a*) *Muscidae*: 2. Lucilia sp. (*b*) *Syrphidae*: 3. Anthrax 2 sp.; 4. Volucella bombylans *L.* (*c*) *Tabanidae*: 5. Tabanus sp. **C. Hymenoptera.** *Apidae*: 6. Apis mellifica *L.*, very common; 7. Bombus agrorum *F.*; 8. B. distinguendus *Mor.*; 9. B. lapidarius *L.*; 10. B. terrester *L.*; 11. Psithyrus vestalis *Fourcr.* **D. Lepidoptera.** *Rhopalocera*: 12. Epinephele janira *L.*; 13. Pieris napi *L.*; 14. Polyommatus phlaeas *L.*; 15. Satyrus semele *L.* All skg. II. Rügen.—**A. Diptera.** *Syrphidae*: 1. Volucella bombylans *L.*; 2. V. pellucens *L.* **B. Hymenoptera.** *Apidae*: 3. Bombus lapidarius *L.* ♀; 4. Psithyrus quadricolor *Lep.* ♂. **C. Lepidoptera.** (*a*) *Rhopalocera*: 5. Argynnis paphia *L.*; 6. Coenonympha pamphilus *L.*; 7. Epinephele janira *L.* (*b*) *Sphingidae*: 8. Zygaena 2 sp. All skg. III. Thuringia ('Blütenbiol. Beob. in Thüringen,' p. 34).—**A. Hymenoptera.** *Apidae* (long-tongued): 1. Bombus hypnorum *L.* ♀; 2. B. soroënsis *F.*, var. proteus *Gerst.* ♂, freq.; 3. B. terrester *L.* ♂. **B. Lepidoptera.** 4. Argynnis adippe *L.*; 5. Pieris sp.; 6. Vanessa urticae *L.* All skg.

Alfken gives the following list for Bremen.—

A. Diptera. *Bombyliidae*: 1. Systoechus sulphureus *Mik.* **B. Hymenoptera.** (*a*) *Apidae*: 2. Andrena nigriceps *K.* ♀; 3. Bombus arenicola *Ths.* ♀; 4. B. confusus *Schenck* ♂; 5. B. derhamellus *K.* ♂; 6. B. hortorum *L.* ♂; 7. B. jonellus *K.* ♀; 8. B. lapidarius *L.* ♀ and ♂; 9. B. lucorum *L.* ♀; 10. B. muscorum *F.* ♀ and ♂; 11. B. proteus *Gerst.* ♀, ♀ and ♂; 12. B. sylvarum *L.* ♀; 13. B. terrester *L.* ♀; 14. Coelioxys quadridentata *L.* ♂, skg.; 15. Halictus flavipes *F.* ♀; 16. H. rubicundus *Chr.* ♀; 17. Megachile argentata *F.* ♀ and ♂; 18. Melitta haemorrhoidalis *F.* ♂; 19. Podalirius bimaculatus *Pz.* ♀ and ♂; 20. Psithyrus barbutellus *K.* ♂; 21. P. vestalis *Fourcr.* ♂. (*b*) *Sphegidae*: 22. Ammophila sabulosa *L.* ♀.

Loew observed the following.—

I. Silesia ('Beiträge,' p. 33).—**A. Diptera.** (*a*) *Bombyliidae*: 1. Systoechus sulphureus *Mik.*, skg. (*b*) *Muscidae*: 2. Echinomyia fera *L.* (*c*) *Syrphidae*: 3. Volucella pellucens *L.*, skg. **B. Hymenoptera.** (*a*) *Apidae*: 4. Bombus variabilis *Schmiedekn.* ♀, skg.; 5. Megachile maritima *K.* ♀, do.; 6. Psithyrus campestris *Pz.* ♀, do. (*b*) *Sphegidae*: 7. Ammophila sabulosa *L.*, skg. **C. Lepidoptera.** *Rhopalocera*: all skg.; 8. Argynnis pandora *S.V.*; 9. Melanargia galatea *L.*; 10. Epinephele janira *L.*; 11. Pieris brassicae *L.*; 12. Polyommatus virgaureae *L.*; 13. Rhodocera rhamni *L.* II. In Brunswick (B.) and the Riesengebirge (R.) (op. cit., p. 51).—**Diptera.** (*a*) *Bombyliidae*: 1. Bombylius minor *L.*, skg. (B.). (*b*) *Muscidae*: 2. Echinomyia ferina *Zett.* (R.). (*c*) *Syrphidae*: 3. Volucella pellucens *L.*, skg. (B.). III. In Switzerland (S.) and the Tyrol (T.) op. cit., p. 60).—**A. Diptera.** *Syrphidae*: 1. Chrysotoxum vernale *Lw.* (S.); 2. Merodon cinereus *F.* (S.); 3. Volucella inanis *L.* (T.). **B. Hymenoptera.** *Apidae*: 4. Osmia sp. (S.). **C. Lepidoptera.** *Rhopalocera*: 5. Melitaea parthenie *Bkh.* (S.).

Sickmann gives the following for Osnabrück.—

Hymenoptera. (*a*) *Apidae*: 1. Biastes emarginatus *Schenk*, very rare. (*b*) *Sphegidae*: 2. Cerceris arenaria *L.*, freq.; 3. C. labiata *F.*; 4. C. quinquefasciata *Rossi*, freq.; 5. C. rybiensis *L.*, do.; 6. Crabro alatus *Pz.*; 7. C. albilabris *F.*, very common; 8. C. brevis *v. d. L.*, freq.; 9. C. panzeri *v. d. L.*, infreq.; 10. C. peltarius *Schreb.*, very common; 11. Dinetus pictus *F.*, do.; 12. Mellinus sabulosus *F.*; 13. Oxybelus nigripes *Oliv.*, infreq.; 14. O. uniglumis *L.*, freq.

Friese observed the following bees in Alsace (A.), Baden (B.), Fiume (F.), and Hungary.—

1. Biastes emarginatus *Schenck*; 2. B. truncatus *Nyl.*, very rare (B.); 3. Colletes hylaeiformis *Ev.*, not freq. (H.); 4. Epeolus productus *Ths.*, rare (F., H.); 5. E. tristis *Sm.*, do. (F., H.); 6. Halictus calceatus *Scop.* ♂, not rare (B.); 7. H. carinaeventris *Mor.* ♀ and ♂ (H.); 8. H. flavipes *F.*, freq. (B.); 9. H. Smeathmanellus *K.*, do. (B.); 10. H. villosulus *K.*, do. (B., A.); 11. Nomia diversipes *Ltr.*, not rare (H.); 12. N. femoralis *Pall.* (H.); 13. Pasites maculatus *Jur.*, not rare (H.).

Herm. Müller (H. M.) and Buddeberg (Budd.) give the following list.—

A. Diptera. (*a*) *Bombyliidae*: 1. Anthrax flava *Mg.*, skg. (H. M., Thuringia); 2. Bombylius canescens *Mik.*, do. (H. M., Thuringia); 3. Exoprosopa capucina *F.*, freq. (H. M.); 4. Systoechus sulphureus *Mik.*, skg. (H. M.). (*b*) *Conopidae*: all skg.; 5. Conops flavipes *L.* (H. M.); 6. Myopa testacea *L.* (H. M.); 7. Physocephala rufipes *F.* (H. M., Thuringia); 8. Sicus ferrugineus *L.* (H. M.). (*c*) *Empidae*; 9. Empis livida *L.*, all skg. (H. M., Thuringia). (*d*) *Muscidae*, all skg.: 10. Echinomyia fera *L.* (H. M.); 11. E. ferox *Pz.* (H. M.); 12. E. grossa *L.*, freq. (H. M.); 13. E. tessellata *F.* (H. M.); 14. Gonia capitata *Deg.* (H. M., Thuringia); 15. Gymnosoma rotundata *L.* (H. M.); 16. Lucilia cornicina *F.* (H. M.); 17. Nemoraea rudis *Fall.* (H. M.); 18. Ocyptera brassicaria *F.*, freq. (H. M.); 19. O. cylindrica *F.*, freq. (H. M.); 20. Sarcophaga albiceps *Mg.*, very common (H. M.); 21. S. carnaria *L.*, do. (H. M.); 22. Ulidia erythrophthalma *Mg.*, in very great numbers in the flowers (H. M., Thuringia). (*e*) *Syrphidae*: all skg.: 23. Eristalis arbustorum *L.*, very common (H. M.); 24. E. pertinax *Scop.*, po-dvg. (H. M.); 25. E. sepulcralis *L.* (H. M.); 26. Merodon aeneus *Mg.* (H. M., Thuringia); 27. Syritta pipiens *L.*, freq. (H. M.); 28. Volucella bombylans *L.* (H. M.). (*f*) *Tabanidae*: 29. Chrysops caecutiens *L.* ♂ (H. M., Thuringia); 30. Tabanus rusticus *L.*, extremely numerous (H. M.). **B. Hymenoptera.** (*a*) *Apidae*: 31. Andrena nigroaenea *K.* ♀, skg. (H. M.); 32. Apis mellifica *L.* ☿, freq., skg. and po-cltg. (H. M.); 33. B. pratorum *L.* ♀, do. (H. M.); 34. B. sylvarum *L.* ☿, skg. (H. M., Thuringia); 35. Cilissa leporina *Pz.* ♀ and ♂, skg. (Budd.); 36. Coelioxys, sp. ♂, skg. (H. M.); 37. Epeolus variegatus *L.* ♀, skg. (Budd.); 38. Halictus cylindricus *F.* ♀, skg. (Budd.); 39. H. interruptus *Pz.* ♀, skg. (Budd.); 40. H. morio *F.* ♀, skg. (Budd.); 41. H. Smeathmanellus *K.* ♀ (Budd.); 42. Megachile centuncularis *L.* ♂, skg. (Budd.); 43. M. circumcincta *K.* ♂, skg. (H. M.); 44. Nomada germanica *Pz.* ♀, skg. (H. M.); 45. Psithyrus barbutellus *K.* ♂, skg. (H. M.); 46. P. quadricolor *Lep.* ♂, skg. (H. M.); 47. Saropoda bimaculata *Pz.* ♀ and ♂, freq. (H. M.). (*b*) *Ichneumonidae*: all skg.: 48. Different sp., skg. (H. M., Thuringia). (*c*) *Sphegidae*: 49. Ammophila campestris *Ltr.* ♂ (H. M., Thuringia); 50. A. sabulosa *L.* ♀ and ♂, freq. (H. M., Thuringia); 51. Cerceris variabilis *Schr.* ♀ and ♂ (H. M.); 52. Lindenius albilabris *F.* (H. M.). **C. Lepidoptera.** (*a*) *Pyralidae*: 53. Botys purpuralis *L.*, skg. (H. M., Thuringia). (*b*) *Noctuidae*: 54. Acontia luctuosa *W.V.*, skg. by day (H. M., Thuringia). (*c*) *Rhopalocera*: all skg.: 55. Argynnis aglaja *L.* (H. M.); 56. A. niobe *L.* (H. M.); 57. Lycaena aegon *S.V.* ♂ (H. M., Thuringia); 58. L. corydon *Scop.*, freq. (H. M., Thuringia); 59. L. icarus *Rott.* (H. M.); 60. Melitaea athalia *Esp.* (H. M.); 61. Pieris napi *L.* (H. M., Thuringia); 62. Satyrus (Coenonympha) arcania *L.* (H. M.); 63. S. (Epinephele) hyperanthus *L.* (H. M.); 64. S. hyperanthus *L.*, var. arete *Müll.* (H. M., Thuringia); 65. S. (Epinephele) janira *L.* (H. M.); 66. S. (Erebia) ligea *L.* (H. M.); 67. S. (Pararge) maera *L.* (H. M.); 68. S. (Coenonympha) pamphilus *L.* (H. M., Thuringia); 69. Thecla ilicis *Esp.* (H. M., Thuringia); 70. T. spini *S.V.* (H. M., Thuringia). (*d*) *Sphingidae*: 71. Sesia empiformis *Esp.* (H. M.); 72. S. tipuliformis *Cl.* (H. M.).

The following were recorded by the observers, and for the localities stated.—

Wüstnei (Holstein), the bee Saropoda rotundata *Pz.* Rössler (Wiesbaden),

2 moths—Coleophora lixella *Zell.*, and Agrotis vestigialis *Hfn.* Hoffer (Steiermark), the humble-bee Bombus hortorum *L.* ♂. Frey (Switzerland), 2 moths—Gelechia distinctella *Zett.*, and Pempellia ornatella *S.V.* (Engadine). Frey-Gessner (Switzerland), the humble-bee Bombus agrorum *F.*, and 2 Scoliids—Scolia hirta *Schr.*, and S. quadripunctata *F.* Schiner (Austria), 2 hover-flies—Merodon cinereus *F.* and Sericomyia borealis *Fall.* Von Fricken (Westphalia), the Chrysomelid beetle Cryptocephalus pygmaeus *F.* Seitz (Darmstadt), the largest German Chrysidid Parnopes grandior *Pall.*, very occasionally in July. Ducke (Austrian Silesia), the bee Andrena simillima *Sm.* von Dalla Torre (Tyrol), 3 bees—1. Anthidium punctatum *Ltr.* ♀; 2. Bombus muscorum *F.* ☿; 3. Chalicodoma manicata *Gir.* ♀. Schletterer (Tyrol), and for Pola (P.), 5 bees—1. Anthidium punctatum *Ltr.*; 2. Bombus terrester *L.*; 3. B. variabilis *Schmiedekn.*; 4. Podalirius vulpinus *Pz.*; 5. Sphecodes gibbus *L.* (P.). Handlirsch, the Sphegid Bembex integra *Pz.* MacLeod (Pyrenees), 11 Hymenoptera; 2 beetles, 8 Lepidoptera, and 11 flies (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 326–7): (Flanders), the honey-bee, 3 humble-bees, one other long-tongued bee, 2 short-tongued bees, 3 hover-flies, and 6 Lepidoptera (op. cit., v, 1893, pp. 366–7, vi, 1894, p. 372). H. de Vries (Netherlands), 2 humble-bees—Bombus agrorum *F.* ♂, and B. terrester *L.* ☿ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875). Scott-Elliot (Dumfriesshire), the honey-bee, freq., 2 humble-bees, and 3 Muscids ('Flora of Dumfriesshire,' p. 136). E. D. Marquard (Cornwall), the bee Andrena coitna *K.* ♂. Herm. Müller (Alps), 30 Diptera, 27 Hymenoptera, and 65 Lepidoptera.

Schulz ('Beiträge,' I, pp. 81–2, II, p. 130) in describing the variety (a) *Chamaedrys* Fries as a species, speaks of it as gynodioecious (often 40–50% female flowers), very seldom gynomonoecious, and in places also androdioecious (e.g. Italy and, according to Delpino, England). In certain parts of the Riesengebirge (between Schmiedeberg and Krummhübel) Schulz observed sporadically female plants only; in other places (e.g. in the Riesengrunde) they were extremely rare. He found similar conditions in Central Thuringia and at Halle. Ludwig states that at the beginning of the flowering season there are more female stocks in bloom than later. Schulz, however, could find no seasonal variation in the frequency with which the two forms of stock came into flower. He says that the size of the usually protandrous, more rarely homogamous hermaphrodite flowers is very variable. Although they are visited by insects at least as often as the female flowers, they bring comparatively few seeds to maturity. Darwin states that the seeds of the hermaphrodite flowers are lighter than those of the female ones. This is disputed by Errera and Gevaert, but Schulz found that in many cases a number of seeds from female flowers were somewhat heavier than a corresponding number from hermaphrodite ones.

Visitors.—MacLeod (Pyrenees) noticed the humble-bee Bombus agrorum *F.* (Bot. Jaarb. Dodonaea Ghent, iii, 1891, p. 338). Schletterer records the humble-bee Bombus terrester *L.* for the Tyrol and Istria, and observed the following bees at Pola.—

1. Anthidium manicatum *L.*; 2. A. septemdentatum *Ltr.*; 3. Andrena albopunctata *Rossi*; 4. A. carbonaria *L.*; 5. A. convexiuscula *K.*, var. fuscata *K.*; 6. A. dubitata *Schenck*; 7. A. flavipes *Pz.*; 8. A. flessae *Pz.*; 9. A. labilis *K.*; 10. A. limbata *Ev.*; 11. A. lucens *Imh.*; 12. A. morio *F.*; 13. Ceratina nigroaenea *Gerst.*; 14. Coelioxys aurolimbata *Foerst.*; 15. Colletes fodiens *K.*; 16. C. lacunatus *Dours.*; 17. C. niveofasciatus *Dours.*; 18. Eucera interrupta *Baer.*; 19. E. parvula *Friese*; 20. E. ruficollis *Brull.*; 21. Halictus fasciatellus *Schenck*; 22. H. leucozonius *Schr.* ♀; 23. H. malachurus *K.*; 24. H. morbillosus *Krchb.*; 25. H. scabiosae *Rossi*; 26. H. sexcinctus *F.*; 27. H. tetrazonius *Klg.*; 28. H.

variipes *Mor.*; 29. H. villosulus *K.*; 30. Megachile argentata *F.*; 31. M. muraria *L.*; 32. Melecta funeraria *Sm.*; 33. Nomada flavoguttata *K.*; 34. N. imperialis *Schmiedekn.*; 35. Osmia aurulenta *Pz.*; 36. O. papaveris *Ltr.*; 37. O. scutellaris *Mor.*; 38. O. vidua *Gerst.*; 39. Podalirius retusus *L.*, var. meridionalis *Pér.*

Warming found the variety (b) *prostata* Hornem. to be gynodioecious with protandrous hermaphrodite flowers in Iceland and Greenland. In consequence of the smallness of the flower the stigma and anthers are so close together that the possibility of self-pollination is increased. The plants in Iceland possess considerably longer stamens and style than those in Greenland. The various female flowers on one plant often present every degree of reduction of the stamens.

Schulz ('Beiträge,' I, p. 83) in describing the variety (c) *angustifolius* Pers. as a species says it is gynodioecious, and also, more frequently, gynomonoecious. All degrees of reduction of the filaments may sometimes be found on the same plant.

The variety (d) *pannonicus* All. is also described as a species by Schulz (op. cit., II, pp. 130–1), who states it to be gynodioecious or rarely gynomonoecious in the South Tyrol and North Italy. The size of the flowers is very variable. Insect-visits are numerous.

Visitors.—Schletterer and von Dalla Torre record the bee Melecta armata *Pz.* for the Tyrol.

2281. T. dalmaticus Freyn.—This is perhaps only a variety of T. Serpyllum.

Visitors.—Schletterer saw the following at Pola.—

Hymenoptera. (*a*) *Apidae*: 1. Andrena albopunctata *Rossi*; 2. A. carbonaria *L.*; 3. A. combinata *Chr.*; 4. A. convexiuscula *K.*, var. fuscata *K.*; 5. A. deceptoria *Schmiedekn.*; 6. A. flavipes *Pz.*; 7. A. humilis *Imh.*; 8. A. labialis *K.*; 9. A. limbata *Ev.*; 10. A. lucens *Imh.*; 11. A. morio *Brull.*; 12. A. nana *K.*; 13. A. parvula *K.*; 14. Bombus terrester *L.*; 15. Colletes niveofasciatus *Dours.*; 16. Eucera interrupta *Baer.*; 17. E. longicornis *L.*; 18. Halictus fasciatellus *Schenck*; 19. H. interruptus *Pz.*; 20. H. levigatus *K.* ♀; 21. H. leucozonius *Schr.* ♀; 22. H. malachurus *K.*; 23. H. minutus *K.*; 24. H. morbillosus *Krchb.*; 25. H. patellatus *Mor.*; 26. H. rufocinctus *Nyl.* a ♀ and a ♂; 27. H. scabiosae *Rossi*; 28. H. sexcinctus *F.*; 29. H. tetrazonius *Klg.*; 30. Lithurgus chrysurus *Fonsc.*; 31. Megachile muraria *Retz.*; 32. M. septemdentatum *Ltr.*; 33. Melecta funeraria *Sm.*; 34. M. luctuosa *Scop.*; 35. Nomada braunsiana *Schmiedekn.*; 36. N. femoralis *Mor.*; 37. N. ruficornis *L.*; 38. N. sexfasciata *Pz.*; 39. Osmia rufohirta *Ltr.*; 40. O. versicolor *Ltr.*; 41. Podalirius tarsatus *Spin.* (*b*) *Pompilidae*: 42. Pompilus viaticus *L.* (*c*) *Scoliidae*: 43. Scolia haemorrhoidalis *F.*; 44. S. hirta *Schr.* (*d*) *Sphegidae*: 45. Cerceris quadrifasciata *Pz.* (*e*) *Vespidae*: 46. Polistes gallica *L.*

2282. T. vulgaris L. (Sprengel, 'Entd. Geh.' pp. 310–11; Herm. Müller, 'Fertilisation,' pp. 474–5; Schulz, 'Beiträge,' II, p. 195; Kirchner, 'Flora v. Stuttgart,' p. 613; Knuth, 'Bloemenbiol. Bijdragen.')—This species is gynodioecious, with protandrous hermaphrodite flowers like those of T. Serpyllum. The female flowers set almost twice as many fruits as the hermaphrodite ones. On cultivated plants at Halle Schulz observed about 20 % female flowers.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (on garden plants), the honey-bee, skg., a hover-fly (Eristalis tenax *L.*, po-dvg. and skg.), and a butterfly (Pieris brassicae *L.*, skg.). Herm. Müller (in his garden at Lippstadt), all skg.—**A. Diptera.** (*a*) *Empidae*: 1. Empis livida *L.*

(*b*) *Muscidae*: 2. Sarcophaga albiceps *Mg.*, freq. (*c*) *Syrphidae*: 3. Syritta pipiens *L.*, freq., po-dvg. **B. Hymenoptera.** (*a*) *Apidae*: 4. Apis mellifica *L.* ☿; 5. Halictus, small sps., po-cltg. (*b*) *Sphegidae*: 6. Ammophila sabulosa *L.* ♀ and ♂. **C. Lepidoptera.** *Sphingidae*: 7. Sesia tipuliformis *Cl.* F. F. Kohl (Tyrol), the true wasp Ancistrocerus renimacula *Lep.*

711. Calamintha Lam.

Protandrous bee or humble-bee flowers; with nectar secreted and stored as usual. Often gynodioecism, more rarely gynomonoecism as well.

2283. C. Acinos Clairv. (= Thymus Acinos *L.*). (Herm. Müller, 'Fertilisation,' p. 477.)—The flowers of this species are bright violet in colour. Warnstorf describes the pollen-grains as white in colour, rounded, indented with several furrows, densely papillose, about 44 μ broad and 50 μ long.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Thuringia), the honey-bee, skg. and po-cltg., and the Bombyliid Systoechus sulphureus *Mik.*, skg. von Dalla Torre (Tyrol), the humble-bee Bombus muscorum *F.* ☿. Schletterer (Tyrol), the humble-bee B. variabilis *Schmiedekn.*: (Pola), 2 bees—Anthidium manicatum *L.*, and A. septemdentatum *Ltr.*

2284. C. alpina Lam. (= Thymus alpinus *L.*). (Herm. Müller, 'Alpenblumen,' pp. 319–21; Schulz, 'Beiträge,' II, pp. 131–2.)—In this species Hermann Müller distinguished between large- and small-flowered stocks with protandrous hermaphrodite flowers. Schulz, however, found three forms in the Tyrol with hermaphrodite flowers of different sizes, the two larger of which (12–16 mm. and 9–12 mm. long) are protandrous and adapted for cross-pollination. The small flowers (5–7 mm.) are feebly protandrous or homogamous and autogamous. Schulz says that in addition to these hermaphrodite types female stocks often occur, and in this case there are again three forms of flower to be seen, their sizes being about $\frac{3}{4}$–$\frac{4}{5}$ of those of the hermaphrodite ones.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller, 12 bees and humble-bees, 4 hover-flies, and 15 Lepidoptera. Schulz, more especially Lepidoptera (about 30 sp.), bees less frequently. Both the foregoing noticed flowers perforated by the humble-bees Bombus mastrucatus *Gerst.* and B. terrester *L.* Loew (Pontresina), a long-tongued bee (Osmia caementaria *Gerst.* ♀, po-cltg.), and a true wasp (Celonites abbreviatus *Vill.*, skg.). MacLeod (Pyrenees), 2 bees, 2 Lepidoptera, a Bombylius, and an Empis (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 327). Loew (Berlin Botanic Garden).—**A. Hymenoptera.** *Apidae*: 1. Anthidium manicatum *L.* ♀, skg.; 2. Apis mellifica *L.* ☿, do.; 3. Bombus agrorum *F.* ☿ and ♂, do.; 4. B. hortorum *L.*; 5. B. hortorum *L.*, var. nigricans *Schmiedekn.* ♂, skg.; 6. B. terrester *L.* ☿, do. **B. Lepidoptera.** *Rhopalocera*: 7. Pieris brassicae *L.*, skg.

2285. C. officinalis Moench (= Melissa Calamintha *L.*). (Schulz, 'Beiträge,' II, p. 196; Knuth, 'Bloembiol. Bijdragen,' 'Blütenbiol. Herbstbeob.')—The flowers of this species are protandrous, and exhibit none of the variations in size found in C. alpina.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel Botanic Garden, 28. 8. '96), the humble-bee Bombus terrester *L.* ♂, freq., skg., the honey-bee, and a hover-fly (Eristalis sp.). Schletterer and von Dalla Torre (Tyrol), 2 bees—Bombus lapidarius *L.*, and Halictus major *Nyl.*

2286. C. Nepeta Savi. (= Melissa Nepeta *L.*). (Herm. Müller, 'Alpenblumen,' p. 321; Schulz, 'Beiträge,' II, p. 196.)—This species is gynodioecious with large hermaphrodite and small female flowers. Schulz says that it is sometimes gynomonoecious in the South Tyrol, with about 25 % female flowers.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 5 humble-bees, a fly, and 5 Lepidoptera. Loew (Berlin Botanic Garden).—**A. Diptera.** *Syrphidae*: 1. Eristalis nemorum *L.* **B. Hymenoptera.** *Apidae*: all skg.: 2. Apis mellifica *L.* ☿; 3. Bombus agrorum *F.* ♂; 4. B. terrester *L.* ♂; 5. Psithyrus vestalis *Fourcr.* ♀ and ♂.

2287. C. grandiflora Moench.—Schulz says that the hermaphrodite flowers of cultivated plants of this species (indigenous to Croatia and the Siebengebirge) are protandrous. Female stocks also occur.

2288. C. umbrosa Fisch. et Mey.—

Visitors.—Loew (Berlin Botanic Garden) observed the humble-bee Bombus agrorum *F.* ☿, skg. and po-cltg.

2289. C. Clinopodium Benth. (= C. vulgare *L.*). (Herm. Müller, 'Fertilisation,' p. 476, 'Alpenblumen,' p. 321; Schulz, 'Beiträge,' p. 83, II, pp. 135, 154, 196; Kirchner, 'Flora v. Stuttgart,' p. 614; Knuth, 'Bloemenbiol. Bijdragen'.)—Hermann Müller describes the corolla-tube of the purple-red flowers of this species as 10–13 mm. long, and not infrequently filled to a height of 3 mm. with nectar. The lower stigmatic branch of the style is a broad, lancet-shaped plate bending downwards and devoid of noticeable papillae; the upper is much narrower and shorter, and even almost absent. Schulz states that there are two different forms of hermaphrodite flowers—(1) Large (16–17 mm. long), strongly protandrous, and (2) small (12–13 mm. long), feebly protandrous, rarely homogamous. The female flowers also vary in size; sometimes they are associated with hermaphrodite ones on the same plant, sometimes they are only found on separate stocks. Schulz occasionally saw the flowers perforated by Bombus terrester *L.* and B. lapidarius *L.*

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth, the butterfly Pieris rapae *L.* Herm. Müller, 2 butterflies, skg.—Pieris brassicae *L.*, and Epinephele hyperanthus *L.*: (Alps), 4 Lepidoptera, 3 humble-bees, skg. legitimately, and a Halictus, do. Loew (Riesengebirge), the butterfly Pieris brassicae *L.* MacLeod (Pyrenees), 4 humble-bees and 2 Lepidoptera (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 331–2). von Dalla Torre (Tyrol), 2 bees—Anthidium manicatus *L.* ♀, and Halictus leucozonius *Schr.* Schletterer (Tyrol), the same two bees, and also Anthidium variegatum *F.* Scott-Elliot (Dumfriesshire), a humble-bee ('Flora of Dumfriesshire,' p. 136). Loew (Berlin Botanic Garden), 2 humble-bees (Bombus agrorum *F.* ♂, and B. terrester *L.* ♂), and a butterfly (Pieris brassicae *L.*), all skg.

712. **Melissa** Tourn.

Protandrous or protogynous to homogamous bee flowers. Sometimes gynodioecism or andromonoecism.

2290. M. officinalis L. (Schulz, 'Beiträge,' II, p. 196; Knuth, Bot. Centralbl., Cassel, lxxii, 1897.)—The strong odour of lemons exhaled by the foliage-leaves of this species is a great attraction to cross-pollinating insects. There is no nectar-guide to be found on the small, whitish flowers (at least not in those observed in the garden of the Kiel Ober-Realschule at the end of August). The broad middle lobe of the lower lip is closely beset with short, stiff, cylindrical hairs, which leave a deep groove down the middle free for an insect's proboscis; the spaces between these hairs are thickly beset with microscopic papillae.

The slightly arched upper lip also possesses small hairs at the entrance to the corolla-tube, which, however, are longer and looser than those on the lower lip. This growth of hair also extends above on to the inner surface of the corolla-tube (which is 8 mm. long and curves downwards), and the way to the nectar secreted and concealed at the base of the flower is therefore quite plainly indicated to the proboscis of an insect. The upper part of the corolla-tube widens out for a distance of about 2 mm. into an opening $2\frac{1}{2}$ mm. high and $2\frac{1}{2}$ mm. broad, so that the head of a small insect can be inserted and a proboscis 6 mm. long can suck all the nectar.

FIG. 332. *Melissa officinalis*, *L*. (1) Flower seen directly from the front: in the entrance the anthers of the two shorter stamens are seen below, and those of the two longer ones above, while the style and stigma are in the middle (× 3½). (2) A flower pulled out of the calyx and seen from the side.

The stigma usually seems to mature shortly before the anthers dehisce, but many flowers are homogamous. The anthers of the two longer stamens dehisce before those of the two shorter ones. The stigma, with its two hook-shaped, diverging branches, is generally situated between the anthers of the two longer stamens, sometimes projecting beyond them, but in other cases being somewhat shorter. It frequently remains receptive until the anthers of the shorter stamens dehisce, but is often completely shrivelled by that time. A considerable number of flowers are entirely devoid of style and stigma. I cannot say whether these varied conditions are also to be found in flowers blooming earlier, having failed to examine them.

On visiting a flower in the purely female stage, therefore, a nectar-seeking insect will brush against the stigma on alighting, and dust it with pollen previously gathered; on visiting a hermaphrodite or entirely male one, it will again be dusted with fresh pollen. Crossing is thus brought about by regular nectar-sucking insects; such visitors can, however, also effect self-pollination in flowers in the hermaphrodite stage. This may also take place in such flowers when the stigma remains receptive long enough, by contact or the falling of pollen, when the stigma is of the same length as the anthers of the two longer stamens, or a little shorter.

Schulz observed single gynodioecious stocks at Bozen, among others with protandrous hermaphrodite flowers.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel Ober-Realschule Garden, 26. 8. '97)—1. the bee Apis mellifica *L.* ☿, occasional, skg. vigorously and effecting crossing; it obviously could not reach the base of the flower with its short (6 mm.) proboscis, not being able to force its head into the widened part of the corolla-tube; 2. the humble-bee Bombus terrester *L.* ♂, freq., skg., and effecting crossing; its proboscis (7–8 mm.) could reach the nectar-storing base of the flower; 3. the hover-fly Rhingia rostrata *L.*, freq., skg., during which its proboscis (10–11 mm.) was not entirely inserted into the corolla-tube, and was therefore dusted with pollen 2–3 mm. from its base; the bees, on the other hand, brought the front of their heads into contact with stigma or anthers; 4. and 5. the hover-flies Syritta pipiens *L.* and Syrphus balteatus *Deg.*, both skg. and effecting either cross- or self-pollination; 6. the Thysanopterid Thrips, frequent in the flowers and occasionally effecting autogamy. Loew (Berlin Botanic Garden), 3 bees, all skg.—1. Apis mellifica *L.* ☿; 2. Bombus agrorum *F.* ♂; 3. B. terrester, *L.* ☿.

713. Horminum L.

Protandrous bee flowers. Gynodioecism, rarely gynomonoecism.

2291. H. pyrenaicum L. (Kerner, 'Schutzmittel d. Blüten,' p. 225; Herm. Müller, 'Alpenblumen,' pp. 318–19; Schulz, 'Beiträge,' II, pp. 134–6; MacLeod, 'Pyreneënbl.,' pp. 327–31.)—The hermaphrodite flowers of this species are so strongly protandrous that automatic self-pollination is excluded. Schulz says that they vary in size. Besides hermaphrodite flowers there are often to be found smaller female ones with reduced anthers, generally growing on separate stocks, rarely on the same as the others. In the Pyrenees also (according to MacLeod), both protandrous hermaphrodite flowers and smaller, gynomonoeciously distributed female ones occur; in fact, those in the lowest verticillaster are generally female and open later than the hermaphrodites situated just above them.

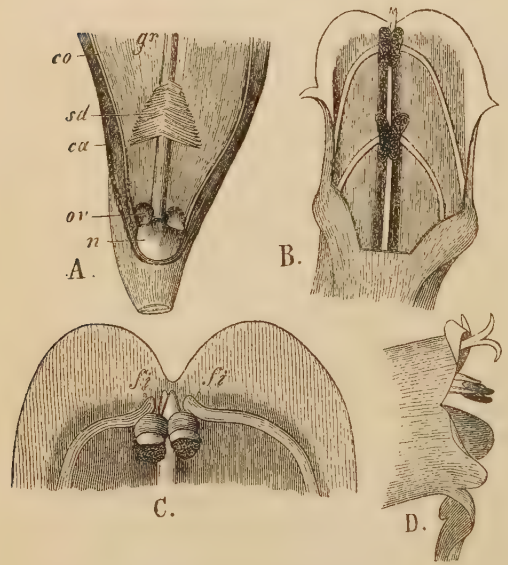


FIG. 333. *Horminum pyrenaicum*, *L.* (from Herm. Müller's Alpenblumen'). *A.* Basal half of a flower, after removal of half the calyx and corolla, seen from below. *B.* Terminal half of do., after removal of the lower lip, seen from below (× 3½). *C.* Ends of the two upper filaments with their processes, seen from the front (× 7). *D.* Entrance of a flower, seen from the side (× 3½). *ca*, calyx; *co*, corolla; *fi*, filaments; *gr*, style; *n*, nectary; *ov*, ovary; *sd*, nectar-cover.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 4 bees, 5 humble-bees, a hover-fly, a beetle, and 2

Lepidoptera. Schulz, 2 humble-bees—Bombus mastrucatus *Gerst.*, and B. terrester *L.*, skg. and also perforating the flowers.

714. Rosmarinus L.

2292. R. officinalis L.—Delpino ('Ult. oss.') describes this species as protandrous. In the second stage of anthesis the stigma assumes the position occupied in the first by the anthers.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Friese, Hungary (H.) and Fiume (F.), 3 bees—1. Eucera caspica *Mor.* (H., F.); 2. Megachile manicata *Gir.* (H., F.); 3. Xylocopa cyanescens *Brullé* (H.). Schletterer, Pola and the Tyrol (T.), a wasp (Polistes gallica *L.*) and 17 bees—1. Andrena carbonaria *L.*; 2. A. flavipes *Pz.*; 3. Bombus argillaceus *Scop.*, skg.; 4. B. pascuorum *Scop.* (T.); 5. B. terrester *L.*; 6. Halictus leucozonius *Schr.* ♀; 7. H. levigatus *K.* ♀; 8. H. malachurus *K.*; 9. H. scabiosae *Rossi*; 10. H. xanthopus *K.*, one ♀; 11. Megachile manicata *Gir.*; 12. Nomada lineola *Pz.*, var. subcornuta *K.*; 13. N. sexfasciata *Pz.*; 14. N. succincta *Pz.*; 15. Osmia rufa *L.*; 16. Podalirius acervorum *L.*; 17. P. crinipes *Sm.*

715. Hyssopus L.

Protandrous bee flowers; with nectar secreted (according to Sprengel) by the base of the ovary.

2293. H. officinalis L. (Sprengel, 'Entd. Geh.,' p. 301; Kirchner, 'Beiträge,' pp. 55–6; Knuth, 'Bloemenbiol. Bijdragen.')—In this species the tube of the deep blue, rarely white corolla is 10 mm. long, its lower half forming a thin, hollow cylinder directed obliquely upwards. In the middle it curves slightly downwards and widens out funnel-wise. Below this curve the lower part of the corolla is indented by two longitudinal folds, rendering the cylinder still narrower, and the access to the base of the flower very small. At first only the somewhat divergent stamens project (the upper ones for 3 mm. and the lower for 6 mm.) beyond the broad corolla-limb, exposing pollen. When the anthers have dehisced the style, which has so far scarcely projected beyond the upper lip, elongates to such an extent that the now diverging stigmatic branches dominate the entrance to the flower. Cross-pollination is therefore ensured by the visits of suitable insects. Automatic self-pollination is not easily effected, even when pollen-grains still cling to the shrivelled anthers.

Kirchner could not find female flowers.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Kerner, the honey-bee. Knuth (Kiel Botanic Garden), 2 humble-bees—Bombus lapidarius *L.* ♂, and B. terrester *L.* ♀. The former sucked persistently, so that nectar would appear to be present, though I was unable to detect it either with a lens or by means of the sense of taste.

716. Nepeta Riv.

Flowers protandrous, belonging to classes **Hb** or **Hhb,** rarely to **LHhb.** Nectar secreted and stored as usual. Gynomonoecism and gynodioecism.

2294. N. Cataria L. (Herm. Müller, 'Alpenblumen,' p. 315; Schulz, 'Beiträge,' I, p. 84, II, p. 196.)—The hermaphrodite flowers of this species are about 7–8 mm. long. The stigma sometimes projects beyond the anthers, or may be of the same length, in which case, however, strong protandry renders self-pollination impossible.

The female flowers are 5–6 mm. long. They occur as a rule (up to 50 %) on the same plants with hermaphrodite ones, and but rarely on separate stocks.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), the humble-bee Bombus agrorum *F.* ☿, skg. Knuth (Kiel Ober-Realschule Garden, 12. 8.'98), the humble-bee B. terrester *L.* ♀, steadily skg. Loew (Berlin Botanic Garden), the hover-fly Syritta pipiens *L.*, po-dvg., and the bee Osmia aenea *L.* ♀, skg.

2295. N. nuda L. (Herm. Müller, 'Weit. Beob.,' III, pp. 53–5; Schulz, 'Beiträge,' II, p. 196.)—The fragrant flowers of this species are arranged in very conspicuous inflorescences. Hermann Müller says that their entrances are marked with numerous bright-purple blotches which serve as guides to the nectar. This is abundantly secreted by the very large base of the ovary. The lower, narrowed part of the corolla-tube is 3 mm. long, and broadens out above to a part of the same length, which allows of the insertion of an insect's head. The upper lip is short, and therefore incapable of protecting the pollen from rain; it is long enough, however, to hold the filaments and style in such a position that a bee visitor must touch the anthers, and (in a later stage) the stigma. The lower lip projects far enough to afford a convenient alighting-platform. At its base and in the mouth of the flower are hairs which prevent rain from entering, or at least render it difficult, but the circlet of hairs commonly found inside the corolla-tube is here absent. At the beginning of anthesis only the pollen-covered anthers project from the flower. Later on the style elongates beyond the stamens and its stigmatic branches diverge. Automatic self-pollination is thus probably excluded. Schulz observed sporadic female stocks besides protandrous hermaphrodite ones.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Thuringia).—**A. Coleoptera.** (*a*) *Mordellidae*: 1. Anaspis frontalis *L.*, an unbidden guest. (*b*) *Nitidulidae*: 2. Meligethes sp., do. **B. Diptera.** *Bombyliidae*: 3. Bombylius canescens *Mik.*, skg., but not pollinating. **C. Hymenoptera.** *Apidae*: 4. Anthidium punctatum *Ltr.* ♂, skg.; 5. Anthophora quadrimaculata *F.* ♂, do.; 6. Apis mellifica *L.* ☿, do., in very large numbers; 7. Bombus agrorum *F.* ♀ and ☿, skg.; 8. B. pratorum *L.* ♀ and ☿, do.; 9. Halictus flavipes *K.* ♀, po-cltg.; 10. H. malachurus *K.* ♀, skg.; 11. Osmia adunca *Ltr.* ♂, in large numbers, skg.; 12. Prosopis communis *Nyl.*, one ♀. **D. Lepidoptera.** *Rhopalocera*: 13. Epinephele janira *L.*, skg.

Loew (Berlin Botanic Garden), the Telephorid beetle Dasytes flavipes *F.*, creeping into the flowers, and 2 bees, skg.—Anthidium manicatum *L.* ♀, and Megachile centuncularis *L.* ♀.

2296. N. Mussini Spreng. (Loew, Ber. D. bot. Ges., Berlin, iv, 1886, pp. 121–3.)—Loew describes the corolla-tube of this Oriental species as about 10 mm. long, and slightly broadened in three places. The stigmatic branches are at first apposed, even when the anthers have dehisced. The style then elongates slightly and the filaments curve sideways, so that a suitable visitor must touch the now mature and diverging stigmatic branches, thus effecting crossing.

Breitenbach (Kosmos, Stuttgart, xiv, 1884) found this species and N. melissaefolia *Lam.* to be gynodimorphous in the Marburg and Göttingen Botanic Gardens.

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Diptera. *Syrphidae*: 1. Syrphus luniger *Mg.*, going from flower to flower, po-dvg. **B. Hymenoptera.** *Apidae*: 2. Andrena dorsata *Sm.* ♀, po-cltg.; 3. Anthidium manicatum *L.* ♀ and ♂, skg.; 4. Anthophora parietina *F.* ♂ and ♀, do.; 5. A. pilipes *F.* ♀, skg. and po-cltg.; 6. A. quadrimaculata *F.* ♀, do.; 7. Apis mellifica *L.* ☿, steadily skg.; 8. Halictus nitidiusculus *K.* ♀, po-cltg.; 9. H. sexcinctus *F.* ♀, skg.; 10. H. sexnotatus *K.* ♀, po-dvg.; 11. Melecta armata *Pz.* ♀, skg.; 12. Osmia adunca *Ltr.* ♀, skg. and po-cltg.; 13. O. aenea *L.* ♀, do.; 14. O. rufa *L.* ♀, skg. **C. Lepidoptera.** (*a*) *Rhopalocera*: 15. Pieris brassicae *L.*, skg.; 16. Vanessa album *L.*, do. (*b*) *Sphingidae*: 17. Ino statices *L.*, skg.

2297. N. melissaefolia Lam.—Loew (op. cit., iv, 1886, p. 123) states that the flower mechanism of this South European species agrees with that of N. Mussini. And *vide* Breitenbach's observation under last species.

Visitors.—Loew observed 6 bees in the Berlin Botanic Garden.—

1. Anthidium manicatum *L.* ♂, skg.; 2. Anthophora furcata *Pz.* ♀, skg. and po-cltg.; 3. A. parietina *F.* ♀; 4. A. quadrimaculata *F.* ♀, skg. and po-cltg.; 5. Bombus hortorum *L.* ♀, skg.; 6. Osmia rufa *L.* ♀, do.

2298. N. macrantha Fisch. (Loew, op. cit., iv, 1886, pp. 124–5, 'Blütenbiol. Floristik,' p. 314.)—Loew has examined plants of this Siberian species cultivated in the Berlin Botanic Garden. The blue flowers, marked with darker longitudinal lines, grow either horizontally or obliquely upwards. The corolla-tube is 20 mm. long, and ventricose above, but narrows to a diameter of 1 mm. lower down. The forwardly-directed lower lip is hairy at its base and projects beyond the upper one. It may be assumed, therefore, that the flowers, like those of Betonica grandiflora, occupy an intermediate position between the classes **Hhb** and **L.** The insect-visits observed by Loew in the Berlin Botanic Garden agree with this.

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Diptera. *Syrphidae*: 1. Pipiza chalybeata *Mg.*, po-dvg.; 2. Syrphus pyrastri *L.*, do. **B. Hymenoptera.** *Apidae*: 3. Anthidium manicatum *L.* ♀, po-cltg. with its forelegs, and transferring it by means of the other legs to its ventral brush, not skg.; 4. Anthophora quadrimaculata *F.* ♀, skg., and then flying to N. melissaefolia; 5. Bombus hortorum *L.* ☿ and ♀, skg. legitimately; 6. Psithyrus vestalis *Fourcr.* ♂, skg. **C. Lepidoptera.** *Rhopalocera*: 7. Pieris brassicae *L.*, skg. legitimately.

2299. N. granatensis Boiss.—

Visitors.—Loew observed three bees, all skg., in the Berlin Botanic Garden.—

1. Anthidium manicatum *L.* ♂; 2. Anthophora quadrimaculata *F.* ♀, po-cltg.; 3. Bombus hortorum *L.* ☿.

2300. N. Glechoma Benth. (= Glechoma hederacea *L.*). (Sprengel, 'Entd. Geh.,' pp. 301–2; Herm. Müller, 'Fertilisation,' pp. 484–6, 'Weit. Beob.,' III, p. 52; Schulz, 'Beiträge,' II, pp. 196, 220; Kirchner, 'Flora v. Stuttgart,' p. 620; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 367–8; Oudemans, Bot. Ztg., Leipzig, xxxi, 1873; Leow, 'Blütenbiol. Floristik,' p. 391; Knuth, 'Bloemenbiol. Bijdragen'; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Möwes, Bot. Jahrb., Leipzig, iv, 1883; Burkill, 'Fertlsn. of Spring Fls.')—The flowers of this species are generally blue-violet, rarely white or pink in colour, and marked with purple blotches on the middle lobe of the lower lip that serve as nectar-guides. The inside of the wider part of the corolla-tube is also blotched below with purple and whitish patches. The interior of the tube is narrowed lower down by stiff, erect hairs, so that an insect's proboscis, on being inserted, must brush the anthers situated under the upper lip, or the stigma, as the case may be. Hermann Müller says that in the large hermaphrodite flowers (corolla-tube 13–16 mm. long and $2\frac{1}{2}$–$4\frac{1}{2}$ mm. broad at the entrance) the anthers as they dehisce downwards during the first stage of anthesis shed their pollen on the backs of visitors. At this time the style projects beyond the anthers and the front margin of the upper lip, with its stigmatic branches still apposed. When the pollen has been scattered, the style elongates and the two stigmatic branches diverge, the lower one still inclining downwards. Self-pollination is therefore excluded, as it is inevitable that the older flowers should be dusted with the pollen of the younger ones. The honey-bee and short-tongued humble-bees frequently perforate the large flowers in order to steal nectar. The corolla-tube of the small female flowers is only $6\frac{1}{2}$–8 mm. long and $1\frac{1}{2}$–$2\frac{1}{2}$ broad at the entrance. Vestiges of stamens may be seen. The style is of the same length as the upper lip, its branches diverging from the first. Schulz found 35–40 % gynomonoeciously or gynodioeciously distributed female flowers. Warnstorf found the species to be gynodioecious at Ruppin; Möwes frequently observed flowers with entirely or partially reduced stamens. In one station at Cambridge Willis found 86 % female flowers at the beginning of the flowering season, and 24 % towards the end; in another station he found 50 % at first and 28 % subsequently. Burkill records gynodioecism for the Yorkshire coast.

Visitors.—Herm. Müller gives the following list.

A. Diptera. (*a*) *Bombyliidae*: 1. Bombylius discolor *Mg.*, skg., only casually effecting pollination; 2. B. major *L.*, freq., do. (*b*) *Syrphidae*: 3. Eristalis intricarius *L.*, po-dvg.; 4. Rhingia rostrata *L.*, skg. **B. Hymenoptera.** *Apidae*: 5. Andrena albicans *Müll.* ♂, vainly skg.; 6. A. fulva *Schr.* ♀, do.; 7. A. fulvicrus *K.* ♀, po-cltg.; 8. Anthophora pilipes *F.* ♀ and ♂, very common; 9. Apis mellifica *L.* ☿, legitimately skg. the small ♀ flowers, either perforating the large hermaphrodite ones, or skg. through holes made by Bombus terrester; 10. Bombus agrorum *F.* ☿ and ♀, skg. legitimately; 11. B. confusus *Schenck* ♀, do.; 12. B. hortorum *L.* ☿ and ♀, do.; 13. B. lapidarius *L.* ☿ and ♀, do. (large hermaphrodite flowers); 14. B. pratorum *L.* ♀, skg. legitimately; 15. B. rajellus *K.* ♀, do.; 16. B. sylvarum *L.* ♀, do.; 17. B. terrester *L.* ♀, stealing nectar by perforating the hermaphrodite flowers and usually the ♀ ones also; 18. Halictus lucidulus *Schenck* ♀, vainly skg.; 19. Nomada varia *Pz.* ♂, legitimately skg. ♀ flowers; 20. Osmia aenea *L.*, one ♀, skg.; 21. O. fusca *Chr.* ♀; 22. O. rufa *L.* ♀ and ♂, skg. both kinds of flowers legitimately; 23. Psithyrus barbutellus *K.* ♀, do.; 24. P. rupestris *F.* ♀, do.; 25. P. vestalis *Fourcr.* ♀, skg.

legitimately. **C. Lepidoptera.** (*a*) *Rhopalocera*: 26. Pieris brassicae *L.*, skg., only casually pollinating; 27. P. rapae *L.*, do. (*b*) *Sphingidae*: 28. Macroglossa fuciformis *L.*, skg., only casually pollinating; 29. M. stellatarum *L.*, do.

Loew (Brandenburg), a Bombyliid (Bombylius major *L.*) and 9 bees ('Beiträge,' p. 43)—1. Andrena parvula *K.* ♀, po-cltg.; 2. Anthophora aestivalis *Pz.* ♂, skg.; 3. A. parietina *F.* ♂, do.; 4. A. pilipes ♂, do.; 5. Bombus pratorum *L.* ♀, skg. and po-cltg.; 6. B. terrester *L.* ♀, do.; 7. Halictus morio *F.* ♀, po-cltg.; 8. Melecta punctata *K.* ♂ and ♀, skg.; 9. Osmia aenea *L.* ♀, do.

Alfken observed 15 bees, skg., at Bremen—1. Bombus agrorum *F.* ♀; 2. B. derhamellus *K.* ♀; 3. B. hortorum *L.* ♀; 4. B. jonellus *K.* ♀; 5. B. lapidarius *L.* ♀; 6. B. muscorum *F.* ♀; 7. B. sylvarum *L.* ♀; 8. Melecta armata *Pz.* ♂; 9. Osmia aurulenta *Pz.* ♀ and ♂; 10. O. caerulescens *L.* ♂; 11. O. rufa *L.* ♂; 12. O. solskyi *Mor.*; 13. Podalirius acervorum *Pz.* ♀ and ♂; 14. P. parietinus *F.* ♂; 15. P. retusus *L.* ♀ and ♂.

The following were recorded by the observers, and for the localities stated.—

Knuth (Schleswig-Holstein), the butterfly Pieris rapae *L.*, skg., and 4 humble-bees, skg.—1. Bombus agrorum *F.*; 2. B. lapidarius *L.*; 3. B. hortorum *L.*; 4. B. terrester *L.*, mostly skg. by perforation. Wüstnei (Alsen), the humble-bee Bombus hortorum *L.* Friese, Baden (B.) and Mecklenburg (M.), 7 bees—1. B. agrorum *F.* ♀, very common (B.); 2. B. jonellus, *K.* ♀, rare (M.); 3. Osmia cornuta *Ltr.*; 4. O. rufa *L.*; 5. O. uncinata *Gerst.*; 6. Podalirius retusus *L.*, not rare (B.); 7. Xylocopa violacea *L.*: (Fiume), 3 bees—1. Bombus agrorum *F.*; 2. Osmia caerulescens *L.*; 3. Xylocopa cyanescens *Brull.* Seitz (Giessen), the bee Podalirius acervorum *L.*, very common. Schletterer (Tyrol), the bee Podalirius tarsatus *Spin.*, freq. MacLeod (Flanders), the honey-bee, 6 humble-bees, 3 short-tongued bees, a hover-fly, and a Lepidopterid (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 368). H. de Vries (Netherlands), 4 humble-bees—1. Bombus agrorum *F.* ♀ and ☿; 2. B. hortorum *L.* ♀ and ☿; 3. B. subterraneus *L.* ♀; 4. B. terrester *L.* ♀ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875). Scott-Elliot (Dumfriesshire), a humble-bee, freq. ('Flora of Dumfriesshire,' p. 137). Burkill (Yorkshire coast), a Nitidulid beetle (Meligethes sp., skg.), a humble-bee (Bombus agrorum *F.*, skg.), and Thrips sp. ('Fertlsn. of Spring Fls.'). E. D. Marquard (Cornwall), the bee Melecta armata *Pz.*, skg. Smith (England), the bee Osmia nigriventris *Zett.* (= O. xanthomelaena *K.*, O. corticalis *Gerst.*).

717. Dracocephalum L.

Protandrous hermaphrodite and gynodioeciously distributed female flowers, belonging to class **Hhb.**

2301. D. austriacum L. (Schulz, 'Beiträge,' II, p. 196.)—Schulz found as many as 10 % female flowers at Vintschgau in the South Tyrol.

2302. D. Ruyschiana L. (Schulz, loc. cit.)—A herbarium specimen from East Prussia was gynodioecious.

2303. D. Moldavica L. (Schulz, loc. cit.; Knuth, 'Bloembiol. Bijdragen.')—Plants of this species cultivated in a garden at Leipzig were gynodioecious.

Visitors.—Knuth (Kiel Botanic Garden) observed 3 humble-bees, flying steadily from flower to flower, and skg.—1. Bombus agrorum *F.* ♀ and ☿; 2. B. lapidarius *L.* ♀ and ♂; 3. B. terrester *L.* ♀.

718. Pycnanthemum Michx.

2304. P. muticum Pers. (= P. pilosum *Nutt.*). (Loew, Ber. D. bot. Ges., Berlin, iv, 1886, pp. 126–7.)—This species is indigenous to North America. The numerous crowded, spotted white flowers are protandrous. The corolla-tube is about 6 mm. long. The spots indicate fly visitors.

2305. P. lanceolatum Pursh. (Loew, op. cit., iv, 1886, pp. 127–8.)—The plant of this species cultivated in the Berlin Botanic Garden bears only purely female flowers.

719. Lophanthus Benth.

2306. L. rugosus Fisch. et. Mey. (Loew, op. cit., iv, 1886, pp. 125–6.)—Loew describes this species as feebly protandrous. The numerous, crowded, strongly aromatic flowers attract large numbers of visitors.

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Diptera. *Syrphidae*: 1. Eristalis tenax *L.*; 2. Syritta pipiens *L.* **B. Hymenoptera.** *Apidae*: all skg.: 3. Apis mellifica *L.* ☿; 4. Bombus agrorum *F.* ☿; 5. B. pratorum *L.* ♀; 6. Psithyrus vestalis *Fourcr.* ♂.

2307. L. chinensis (= Nepeta lophantha *Fisch. et Mey.*).—

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Diptera. *Syrphidae*: 1. Syrphus balteatus *Deg.* **B. Hymenoptera.** *Apidae*: 2. Bombus agrorum *F.* ♂, skg.; 3. Halictus sexnotatus *K.* ♀, po-cltg.; 4. Psithyrus vestalis *Fourcr.* ♂, skg. **C. Lepidoptera.** *Rhopalocera*: 5. Pieris brassicae *L.*, skg.

2308. L. anisatus Benth.—

Visitors.—Loew (Berlin Botanic Garden) observed the humble-bee Bombus agrorum ♂, skg.

2309. L. scrophulariaefolius Benth.—

Visitors.—Loew (Berlin Botanic Garden) observed the humble-bee Bombus agrorum *F.* ♀, steadily skg., and 2 bugs—Corizus parumpunctatus *Schill.*, and Sehirus biguttatus *L.*

720. Ziziphora L.

2310. Z. capitata L. (Willis, J. Linn. Soc., Bot., London, xxx, 1895.)—The small inconspicuous flowers of this species are regularly self-pollinated in England. The length of the corolla-tube (9 mm.) adapts them to bees or hover-flies.

721. Melittis L.

Protandrous revolver flowers belonging to class **Hhb** or **Lm.**

2311. M. Melissophyllum L. (Herm. Müller, 'Weit. Beob.,' III, p. 52; Stadler, 'Beiträge,' pp. 12–16; Schulz, 'Beiträge,' II, pp. 136–8; Bonnier, 'Études anat. et physiol. d. nectaires,' pp. 31, 54; Kerner, 'Nat. Hist. Pl.,' Eng. Ed., 1, II, p. 569.)—Kerner says that the flowers of this species are always white in the

South Tyrol and purplish-white in Lower Austria and Hungary; near Zurich, however (according to Stadler), they are reddish or white with purple nectar-guides on the lower lip. They are very fragrant and markedly protandrous, self-pollination being therefore generally excluded. During dehiscence of the anthers, which are situated in the upper part of the entrance of the flower and dehisce downwards, the style is so short that the still immature stigma lies between the anthers of the short stamens or slightly higher. As a rule it is only after dehiscence, or towards the end of it, that the style elongates and curves slightly downwards in such a way that the now mature stigma is brought under the anthers of the longer stamens or a little in front of them. Bonnier asserts that this species possesses a reduced nectary, but Schulz considers this view ill-founded. The latter describes the nectary as a slightly cylindrical swelling under the ovary, rarely thickened in front, and secreting nectar so very abundantly that the corolla-tube (25–35 mm. long) is filled with it to a height of 7–10 mm. Stadler also found the nectary to be much more strongly developed in front than elsewhere. There is a thick growth of hair serving as a nectar-cover. As the corolla-tube is narrowed by two longitudinal folds, to which the filaments are united, two narrow entrances are formed (and three in the mouth of the flower), situated one above the other. Kerner describes this as characteristic of 'revolver flowers' (cf. e. g. Gentiana, p. 100, and Convolvulus, p. 143).

Visitors.—These are humble-bees and hawk-moths. Hermann Müller, junior, observed Bombus hortorum *L.* Schulz says that long-tongued humble-bees need not penetrate very far into the corolla to reach the nectar; the short-tongued ones, on the contrary, are obliged to probe very deeply, and even then do not quite reach the bottom of it on account of the length of the corolla-tube. The white-flowered variety *albida* Guss. seems specially adapted for fertilization by hawk-moths. Schulz caught Deilephila euphorbiae *L.*, D. elpenor *L.*, and Sphinx convolvuli *L.* at Bozen. He also observed larger moths (Noctuids and Bombycids?), but was unable to capture them. Beetles, flies, small hymenoptera and physopods occurred as useless visitors. Schulz occasionally found the flowers perforated at the base. Stadler observed Bombus terrester *L.* as a nectar-thief.

722. Lamium L.

Red or white homogamous humble-bee or bee flowers; with nectar secreted by the fleshy base of the ovary, which is generally more strongly developed below, and stored at the bottom of the corolla-tube. There is usually a nectar cover in the form of a circle of hairs above the secretion. The galeate upper lip shelters the anthers, and the lower lip forms a convenient alighting-platform for visitors. Schulz says that the stamens of almost all the German species are now and then reduced. Sometimes cleistogamy.

2312. L. album L. (Sprengel, 'Entd. Geh.,' pp. 302–4; Herm. Müller, 'Fertilisation,' pp. 493–5, 'Alpenblumen,' p. 311, 'Weit. Beob.,' III, p. 64; Schulz, 'Beiträge,' II, p. 221; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 117; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 369; Kirchner, 'Flora v. Stuttgart,' p. 621; Loew, 'Blütenbiol. Floristik,' pp. 391, 399.)—In the flowers of this species the white (rarely pinkish) corolla possesses a pale yellow lower lip marked with olive-green

dots. The nectary, which is situated below the ovary, broadens out below into a fleshy lobe surrounding the lower half of the anterior part of the ovary. Nectar collects in the lowest, narrowest part of the corolla-tube, which is 10 mm. long, and is covered by a dense circlet of hairs. Above this the corolla-tube suddenly widens out, and instead of running obliquely becomes vertical. On account of the length of the corolla-tube the nectar is only accessible to long-tongued humble-bees and bees. These touch first the lower stigmatic branch and then the anthers, which mature simultaneously. One of the stigmatic branches continues the direction as the style, and lies therefore between or above the anthers; the other bends down between them in the middle, so that its tip projects below the anthers and is therefore first touched by hymenopterous visitors. If insect-visits fail, automatic self-pollination takes place in consequence of the simultaneous maturation and relative position of stigma and anthers; this method is, however, seldom made use of, on account of the frequency of insect-visits. Warnstorf describes the pollen-grains as pale yellow in colour, ellipsoidal, delicately tuberculate, 41 μ long and 27 μ wide.

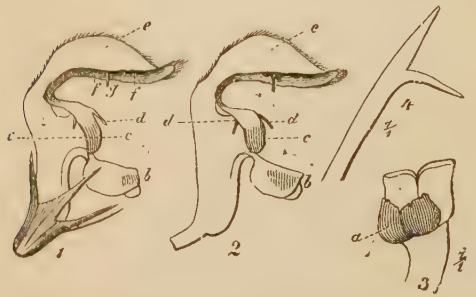


FIG. 334. *Lamium album*, *L.* (after Herm. Müller). (1) Flower seen from the side. (2) Do., after removal of the calyx. (3) Ovary and nectary (× 7). (4) End of the style (× 7). *a*, nectary; *b*, lower lip; *c*, lateral lobes, between which the heads of humble-bees are pushed; *d*, useless appendages: *e*, upper lip (sheltering roof); *f*, stamens; *g*, lower stigmatic branch.

VISITORS.—These are long-tongued hymenoptera, particularly humble-bees: the visitor's head is conveniently inserted between two upright lobes lying between the corolla-tube and the lower lip, and continuing its side walls. While sucking the bee clings to the base of the lower lip with its forelegs, and with its middle and hind ones to the two lobes of this lip, so that a proboscis of not less than 10 mm. long can reach the nectar-bearing base of the flower. Meanwhile the thorax, and in the case of smaller workers the base of the abdomen also, fill up the space between upper and lower lips so accurately that the former closely surrounds the upper side of the visitor, and the stigma and anthers are pressed tightly against its back.

Humble-bees with proboscides too short to reach the nectar (e. g. Bombus terrester *L.*) perforate the corolla-tube and steal it. Short-tongued bees (including the honey-bee) suck nectar through the holes made by B. terrester.

VISITORS.—Herm. Müller gives the following list.—

A. Diptera. *Syrphidae*: 1. Rhingia rostrata *L.*, skg. and po-dvg. **B. Hymenoptera.** *Apidae*: 2. Andrena albicans *Müll.* ♀, po-cltg.; 3. A. nitida *Fourc.* ♀, skg. through holes made by Bombus terrester; 4. Anthidium manicatum *L.* ♀ and ♂, skg. (Strasburg); 5. Anthophora personata *Ill.* ♀ and ♂, do. (Strasburg); 6. A. pilipes *F.* ♀ and ♂, do.; 7. Apis mellifica *L.* ☿, skg. through holes made by Bombus terrester; 8. Bombus agrorum *F.* ☿ and ♀, skg. and transferring pollen from the upper side to its baskets; 9. B. hortorum *L.* ☿ and ♀, do.; 10. B. lapidarius *L.* ☿ and ♀, do.; 11. B. muscorum *F.* ♀, as B. agrorum; 12. B. pratorum

L. ♀, do.; 13. B. rajellus *K.* ♀, do.; 14. B. scrimshiranus *K.* ♀ and ☿, do., creeping very far into the flowers; 15. B. sylvarum *L.* ♀, do.; 16. B. terrester *L.* ♀, skg. by perforation; 17. Eucera longicornis *L.* ♂, skg.; 18. Halictus levigatus *K.* ♀, po-cltg.; 19. Melecta armata *Pz.* ♀, skg.; 20. Xylocopa violacea *L.* ♀ and ♂, do. (Strasburg).

Alfken records the following 21 bees, skg., for Bremen.—

1. Anthidium manicatum *L.* ♀; 2. Bombus agrorum *F.* ♀ and ☿; 3. B. Arenicola *Thoms.* ♀; 4. B. derhamellus *K.* ♀; 5. B. distinguendus *Mor.* ♀, ☿ skg.; 6. B. hortorum *L.* ♀, freq. and ☿; 7. B. hortorum *L.*, var. nigricans *Schmiedekn.* ♀; 8. B. jonellus *K.* ☿; 9. B. lapidarius *L.* ♀; 10. B. lucorum *L.* ♀; 11. B. muscorum *F.* ♀ and ☿; 12. B. pratorum *L.* ☿; 13. B. ruderatus *F.* ♀; 14. B. sylvarum *L.* ♀, ☿, and ♂; 15. B. subterraneus *L.* ♀; 16. B. terrester *L.* ♀, perforating even the flower-buds; 17. B. variabilis *Schmiedekn.* ♂; 18. Osmia caerulescens *L.* ♀ and ♂; 19. O. rufa *L.* ♀; 20. Psithyrus barbutellus *K.* ♀; 21. P. vestalis *Fourcr.* ♀.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Schleswig-Holstein), the honey-bee, as a nectar-thief, and 2 humble-bees —Bombus lapidarius *L.*, skg., and B. terrester *L.*, as a nectar-thief. Herm. Müller (Alps), 6 humble-bees. Höppner (Bremen), 2 bees—Andrena convexiuscula *K.* and Bombus proteus *Gerst.* Schmiedeknecht (Thuringia), 5 bees—1. Bombus agrorum *F.* ♀; 2. B. hortorum *L.* ♀; 3. B. hypnorum *L.* ♀; 4. B. jonellus *K.* ♀; 5. Osmia aurulenta *Pz.* ♀ and ♂. Friese (Thuringia), the humble-bee Bombus hortorum *L.*: (Baden and Alsace), the bee Podalirius acervorum *L.*: (Hungary), the bee Halictus xanthopus *K.* ♀ and ♂. Krieger (Leipzig), 5 bees—1. Anthidium manicatum *L.*; 2. Crocisa scutellaris *F.*; 3. Melecta armata *Pz.* (=M. punctata *K.*); 4. Osmia rufa *L.*; 5. Podalirius vulpinus *Pz.* Hoffer (Steiermark), 2 bees—Bombus agrorum *F.* ♀ and ☿, and B. argillaceus *Scop.* ♀. Schletterer (Tyrol), 5 bees—1. Bombus argillaceus *Scop.*; 2. B. hortorum *L.*; 3. B. variabilis *Schmiedekn.*; 4. Eriades florisomnis *L.*; 5. Osmia xanthomelaena *K.* (= O. fuciformis *Gerst*). von Dalla Torre (Tyrol), 2 humble bees—Bombus mesomelas *Gerst.*, and B. muscorum *F.* Loew (Brandenburg), 2 bees—Bombus hortorum *L.* ☿, skg. and po-cltg., and Osmia bicornis *L.* ♀, skg. ('Beiträge,' p. 44): (Switzerland), 2 bees—Anthophora sp. ♀, skg., and Bombus sylvarum *L.* ☿, do. (op. cit., p. 61): (Berlin Botanic Garden), 4 bees—1. Anthidium manicatum *L.* ♂ and ♀, skg.; 2. Apis mellifica *L.* ☿, vainly skg., its head and thorax dusted with pollen; 3. Bombus pratorum *L.* ☿, po-cltg.; 4. B. terrester *L.* ☿, vainly skg.: and on the var. *verticillatum* the humble-bee Bombus lapidarius *L.* ♀, po-cltg. MacLeod (Flanders), 6 humble-bees, and 2 hover-flies (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 372). Scott-Elliot (Dumfriesshire), 3 humble-bees, and a hover-fly ('Flora of Dumfriesshire,' p. 140).

2313. L. maculatum L. (Herm. Müller, 'Fertilisation,' pp. 496–7, 'Alpenblumen,' p. 311, 'Weit. Beob.,' iii, pp. 46–7; Kirchner, 'Flora v. Stuttgart,' p. 622; Loew, 'Blütenbiol. Floristik,' p. 391; Knuth, 'Bloemenbiol. Bijdragen.')—The flowers of this species are purple-red in colour, a darker red and white patch on the lower lip serving as a nectar-guide. Their mechanism agrees with that of L. album, but the corolla-tube is 15–17 mm. long, so that a humble-bee which pushes its head 5 mm. deep into the enlargement of the corolla-tube must have a proboscis 10–12 mm. long in order to reach to the base of the flower. This species again is perforated by Bombus terrester *L.*

Visitors.—Herm. Müller (H. M.) and Buddeberg (Budd.) give the following list.—

A. Diptera. *Syrphidae*: 1. Rhingia rostrata *L.*, vainly trying to suck (H. M.). **B. Hymenoptera.** *Apidae*: 2. Anthophora aestivalis *Pz.* ♀, freq., skg. and po-cltg. (H. M., Thuringia); 3. A. pilipes *F.* ♀ and ♂, skg. (H. M., Thuringia); 4. Apis

mellifica *L.* ☿, po-cltg., approaching from above and clinging to the upper lip (H. M., Thuringia); 5. Bombus agrorum *F.* ♀, very common, skg. (H. M., also in the Alps); 6. B. hortorum *L.* ☿ and ♀, do. (H. M.); 7. B. rajellus *K.* ☿, stealing nectar through the holes made by B. terrester (H. M.); 8. B. terrester *L.* ♀, creeping into the flowers (Budd.).

The following were recorded by the observers, and for the localities stated.—

Knuth (Westphalia), 2 humble-bees—Bombus hortorum *L.*, skg. legitimately, and B. terrester *L.*, skg. by perforation (Schulz also observed the latter as a nectar-thief): (Rosstrappe near Thale, Harz Mts.), Bombus hortorum *L.*, skg., 11. 10. '97. Loew, Brandenburg (B.) and Anhalt (A.), 4 bees—1. Anthophora aestivalis *Pz.* ♂, skg. (B.); 2. A. pilipes *F.* ♀, do. (B.); 3. Eucera longicornis *L.* ♂, do. (A.); 4. Osmia aenea *L.* ♂ (B.) ('Beiträge,' p. 44): (Berlin Botanic Gardens). Friese (Thuringia), 2 bees—Andrena spinigera *K.* and Bombus pomorum *Pz.*, var. rufescens *Ev.* Schmiedeknecht, the humble-bee Bombus agrorum *F.* ♀ and ☿, very common; Hoffer (Steiermark), do., skg. Schletterer, Tyrol (T.), and at Pola.—**Hymenoptera.** (*a*) *Apidae.* 1. Bombus argillaceus *Scop.*; 2. B. hortorum *L.* (T.); 3. B. lapidarius *L.* (T.); 4. B. mastrucatus *Gerst.* (T.); 5. Eucera longicornis *L.*; 6. Halictus sexcinctus *F.* (T.); 7. Nomada furva *Pz.*; 8. Podalirius acervorum *L.*; 9. P. crinipes *Sm.* (*b*) *Ichneumonidae*: 10. Pimpla inquisitor *Scop.* von Dalla Torre (Tyrol), 4 bees—1. Bombus hortorum *L.* ☿; 2. B. lapidarius *L.*; 3. B. mastrucatus *Gerst.* ☿; 4. Halictus sexcinctus *F.* ♀.

Loew (Berlin Botanic Gardens).—

A. Diptera. *Syrphidae*: 1. Pipiza chalybeata *Mg.*, po-dvg. **B. Hymenoptera.** (*a*) *Apidae*: 2. Anthophora pilipes *F.* ♂, skg., covering the front of its head with pollen; 3. Apis mellifica *L.* ☿, po-cltg., and vainly skg.; 4. Bombus hortorum *L.* ♀, skg., and then going to L. orvala. (*b*) *Vespidae*: 5. Vespa germanica *F.* ♀, skg. on flowers with fallen corolla. **C. Lepidoptera.** *Pyralidae*: 6. An undetermined sp., skg (?): on the var. *hirsutum*, 3 bees—1. Bombus hortorum *L.* ☿, skg.; 2. Halictus nitidiusculus *K.* ♀, po-cltg.; 3. Osmia rufa *L.* ♀, skg.

2314. L. purpureum L. (Sprengel, 'Entd. Geh.,' pp. 304–6; Herm. Müller, 'Fertilisation,' p. 497, 'Weit. Beob.,' III, p. 47; Kirchner, 'Flora v. Stuttgart, p. 622; Loew, 'Blütenbiol. Floristik,' p. 391; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 118, 165.)—In the flowers of this species the bright-purple corolla possesses dark-red blotches on the lower lip and dark-red lines at the mouth. The mechanism agrees with that of L. album, but the corolla-tube is only 10–11 mm. long, its upper 4–5 mm. being so widened that it can accommodate a bee's whole head. A proboscis 6 mm. long, therefore, such as that of the honey-bee, can suck all the nectar. Should insect-visits fail, automatic self-pollination takes place, which (according to Hermann Müller's investigations) is effective. Warnstorf describes the pollen-grains as yellow in colour, smooth, ellipsoidal, about 30 μ long and 20–25 μ broad.

Visitors.—Herm. Müller (H. M.) and Buddeberg (Budd.) give the following list.—

A. Diptera. *Bombyliidae*: 1. Bombylius major *L.*, skg. (H. M.). **B. Hemiptera.** 2. Pyrrhocoris apterus *L.*, vainly searching for nectar (H. M.). **C. Hymenoptera.** *Apidae*: 3. Anthophora pilipes *F.* ♂ and ♀ skg., ♀ sometimes also po-cltg. (H. M., Budd.); 4. Apis mellifica *L.* ☿, skg., and sometimes brushing off the pollen with its head and cltg. it (H. M.); 5. Bombus agrorum *F.* ♀, do. (H. M.); 6. B. hortorum *L.* ♀, do. (H. M.); 7. B. lapidarius *L.* ♀, skg. (H. M.); 8. B. pratorum *L.* ♀, as Apis mellifica (H. M.); 9. B. rajellus *K.* ♀, skg. (H. M.); 10. B. terrester *L.* ♀, do., sometimes by perforation (H. M.); 11. Chelostoma florisomne *L.* ♀, skg. (Budd.); 12. Eucera longicornis *L.* ♂, do. (Budd.); 13. Halictus

cylindricus *F.* ♀, vainly searching for nectar (H. M.); 14. H. leucopus *K.* ♀, do. (H. M.); 15. H. sexnotatus *K.* ♀, do. (H. M.); 16. Melecta armata *Pz.* ♀ and ♂, skg. (H. M., Budd.); 17. Osmia adunca *Pz.* ♂, casually skg. (Budd.); 18. O. rufa *L.* ♂, skg. (H. M.). **D. Lepidoptera.** *Rhopalocera*: 19. Rhodocera rhamni *L.*, skg. (H. M.).

The following were recorded by the observers, and for the localities stated.—

Knuth (North Frisian Is.), the honey-bee and 2 humble-bees. Alfken (Bremen), 2 humble-bees—Bombus muscorum *F.* ♀, skg., and B. terrester *L.* ♀ and ☿, do. Höppner (Bremen), 14 bees—1. Andrena nigroaenea *K.*; 2. A. tibialis *K.* ♀; 3. Bombus agrorum *F.* ♀; 4. B. lapidarius *L.* ♀; 5. B. muscorum *F.* ♀; 6. B. rajellus *K.*; 7. B. sylvarum *L.* ♀; 8. B. terrester *L.* ♀; 9. B. variabilis *Schmiedekn.* ♀; 10. Halictus calceatus *Scop.* ♀; 11. H. leucozonius *Schr.* ♀; 12. Osmia caerulescens *L.* ♀ and ♂; 13. O. solskyi *Mor.* ♀ and ♂; 14. Psithyrus campestris *Pz.*; Schmiedeknecht (Thuringia), the bee Osmia aurulenta *Pz.* Friese (Thuringia), the bee Osmia andrenoides *Spin.*: (Nassau, *teste* Buddeberg) the bee Andrena neglecta *Dours*, one ♀. Loew (Brandenburg), 2 bees—Anthophora pilipes *F.* ♂, skg., and Osmia bicornis *L.* ♂, do. ('Beiträge,' p. 44): (Silesia), 2 bees—Anthidium manicatum *L.* ♀, skg. and po. cltg., and Anthophora quadrimaculata *F.* ♀ and ♂ skg., ♀ also po-cltg. (op. cit., p. 34). Hoffer (Steiermark), the humble-bee Bombus terrester *L.* ♀. Schletterer and von Dalla Torre, Tyrol and Pola (P.), 11 bees—1. Andrena nigroaenea *K.*; 2. Bombus derhamellus *K.*; 3. B. sylvarum *L.*; 4. B. variabilis *Schmiedekn.*; 5. Halictus albipes *F.*; 6. H. smeathmanellus *K.*; 7. H. tumulorum *L.*; 8. Melecta armata *Pz.*; 9. Podalirius acervorum *L.* (P. and T.); 10. P. retusus *L.*, do.; 11. Prosopis annulata *L.* (=P. borealis *Nyl.*). Schletterer (Pola), the 2 bees Anthidium manicatum *L.*, and Eucera longicornis *L.*, as well as the 2 sp. of Podalirius. Scott-Elliot (Dumfriesshire), a humble-bee ('Flora of Dumfriesshire,' p. 140). Burkill (Yorkshire coast), ('Fertilizn. of Spring Fls.').—**A. Diptera.** *Muscidae*: 1. Lucilia cornicina *F.*, po-dvg.; 2. Sepsis nigripes *Mg.*, nect.-skg. **B. Hymenoptera.** *Apidae*: 3. Bombus agrorum *F.*, skg. **C. Lepidoptera.** *Rhopalocera*: 4. Vanessa urticae *L.*, skg. Saunders (S.) and Smith (Sm.) (England), 2 bees—Anthidium manicatum *L.* (Sm.), and Podalirius vulpinus *Pz.* (S., Sm.).

2315. L. amplexicaule L. (Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.,' p. 74; Herm. Müller, 'Fertilisation,' p. 496, 'Weit. Beob.,' III, pp. 47–8; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 392; Hoffmann, Bot. Ztg., Leipzig, xli, 1883, pp. 294–7; Kirchner, 'Flora v. Stuttgart,' p. 622; Knuth, 'Bloemenbiol. Bijdragen.') —The corolla-tube of the purple-red flowers of this species is 10–11 mm. long, the upper 4 mm. being so expanded that a humble-bee can insert its head. The mechanism agrees with that of L. album, but the corolla-tube is glabrous internally, and the flowers are not always invariably homogamous, but occasionally feebly protandrous. Automatic self-pollination usually takes place soon after the beginning of anthesis. Hansgirg states that in bad weather the flowers sometimes remain pseudo-cleistogamously closed. Genuine cleistogamy is also comparatively frequent. Kerner says that cleistogamous flowers are to be found in late autumn and early spring. Hoffmann, in the summer, also observed entirely cleistogamous stocks, besides those of mixed character or purely chasmogamous. In July and August I found cleistogamous flowers in which the stigma and anthers were fully mature and situated close together (cf. Vol. I, Fig. 8, p. 55). Warnstorf states (Verh. bot. Ver., Berlin, xxxviii, 1896) that in gardens and fields near Ruppin from May until autumn cleistogamous flowers are commoner than chasmogamous ones. The pollen-grains are saffron yellow in colour, ellipsoidal, finely tuberculate, about 50 μ long and 35 μ broad.

Visitors.—These are rare. The following were recorded by the observers, and for the localities stated.—

Herm. Müller, 2 bees—Anthophora pilipes *F.* ♂ and ♀, skg., and Melecta armata *Pz.*, skg. Knuth, on one occasion, the humble-bee Bombus hortorum *L.* ♀, skg. Höppner (Bremen), 6 bees—1. Apis mellifica *L.* ☿; 2. Bombus agrorum *F.* ♀; 3. B. muscorum *F.* ♀; 4. B. sylvarum *L.* ♀; 5. B. terrester *L.* ♀; 6. Halictus sp.

2316. L. incisum Willd. (=L. dissectum *With.*, L. hybridum *Vill.*, L. guestfalicum *Weihe*, and, according to the *Index Kewensis*, L. purpureum *L.*). (Herm. Müller, 'Fertilisation,' p. 498; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 370.)—

Visitors.—Herm. Müller observed 5 bees—1. Anthophora pilipes *F.* ♀ and ♂, skg.; 2. Apis mellifica *L.* ☿, do.; 3. Bombus pratorum *L.* ♀, do.; 4. B. rajellus *K.* ♀, do.; 5. Halictus cylindricus *F.* ♀, vainly skg.

2317. L. Orvala L. (Loew, Ber. D. bot. Ges., Berlin, iv, 1886, pp. 119–20, 'Blütenbiol. Floristik,' p. 311.)—This species, indigenous to South Europe, Steiermark, and Carniola, has been studied by Loew in the Berlin Botanic Garden. The large, brown-purple flowers are over 30 mm. long, and the corolla-tube about 15 mm. in length, expands into a sort of pouch (16 mm. long and 3 mm. broad) marked with dark longitudinal lines. It is provided with several lateral teeth, which probably serve as holdfasts for visitors; the lower lip is joined to the pouch as a sort of appendage. The stigmatic branches are situated in front of the glabrous anthers, which mature simultaneously, being therefore first touched by a humble-bee visitor and dusted with pollen. The corolla-tube is so greatly expanded that a humble-bee can insert its head and the front part of its thorax; a proboscis 15 mm. long can therefore suck all the nectar. This is secreted by a nectary greatly enlarged in front, and protected by a circlet of hairs.

Visitors.—Loew saw the humble-bee Bombus hortorum *L.*, skg. legitimately, and the honey-bee, vainly skg.

2318. L. garganicum L. (Loew, Ber. D. bot. Ges., Berlin, iv, 1886, pp. 120–1.) —Loew states that the flower mechanism of this species resembles that of L. Orvala, but the pouch-like enlargement of the corolla-tube is much smaller, and the circlet of hairs is almost or entirely absent. The stigma is situated between the anthers, while the lower stigmatic branch projects below them.

Visitors.—Loew observed 7 bees in the Berlin Botanic Garden—1. Anthidium manicatum *L.* ♂, skg.; 2. Anthophora pilipes *F.* ♂ and ♀, do., the front of its head dusted with pollen; 3. Apis mellifica *L.* ☿, vainly skg., its head and thorax dusted with pollen; 4. Bombus hortorum *L.* ♀, skg., then going to L. Orvala; 5. B. pratorum *L.* ☿, po-cltg.; 6. Halictus sexnotatus *K.* ♀, do.; 7. Osmia aenea *L.* ♀, creeping far into the flowers and skg.

2319. L. flexuosum Tenore.—

Visitors.—Loew observed 6 bees in the Berlin Botanic Garden.—

1. Anthidium manicatum *L.* ♀ skg., ♂ swarming round the flowers; 2. Apis mellifica *L.* ☿, vainly skg., its head and thorax dusted with pollen; 3. Bombus hortorum *L.* ♀, skg.; 4. Halictus sexnotatus *K.* ♀, po-cltg.; 5. Osmia aenea *L.* ♀, do.; 6. O. rufa *L.* ♂, skg.

2320. L. Galeobdolon Crantz (=Galeobdolon luteum *Huds.*, and Galeopsis

Galeobdolon *L.*). (Herm. Müller, 'Fertilisation,' p. 496, 'Alpenblumen,' p. 311, 'Weit. Beob.,' III, p. 48; Kirchner, 'Flora v. Stuttgart,' p. 623; Schulz, 'Beiträge,' II, p. 221; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 368; Knuth, 'Bloemenbiol. Bijdragen.')—The mechanism of the yellow flowers of this species agrees essentially with that of L. album. The corolla-tube is 8 mm. long, but broad enough to enable a bee with a proboscis 6 mm. long (and therefore the honey-bee) to reach the base of the flower. The upper lip again corresponds exactly to the shape of the bee or humble-bee's body. At the beginning of anthesis the tip of the downwardly-directed stigmatic branch is situated slightly above the lower surface of the anthers. It is therefore not touched when a humble-bee merely brushes the anthers lightly with its back: when a large one, however, presses the anthers more strongly upwards, its tip is struck, but not on the same spot as the anthers. Cross-pollination consequently takes place more easily than self-pollination. Later on the tip of the stigmatic branch protrudes downwards between the anthers, so that it comes into contact with visitors before they brush against these, and cross-pollination is effected. Should insect-visits fail, automatic self-pollination generally takes place, pollen falling naturally on to the lower stigmatic branch. Warnstorf describes the pollen-grains as pale yellow in colour, ellipsoidal, delicately tuberculate, about 37 μ long and 27 μ broad.

Visitors.—Herm. Müller (H. M.) and Buddeberg (Budd.) give the following list.—

A. Diptera. *Syrphidae*: 1. Rhingia rostrata *L.*, skg. (Budd.). **B. Hymenoptera.** *Apidae*: 2. Anthophora personata *Ill.* ♀, skg. (H. M., Strassburg); 3. Apis mellifica *L.* ☿, on one occasion skg. legitimately, but generally stealing nectar through holes made by Bombus terrester; 4. Bombus agrorum *F.* ♀, very numerous, skg. legitimately, and brushing pollen from above into its collecting-baskets; 5. B. hortorum *L.* ♀, do. (H. M.); 6. B. pratorum *L.* ☿ and ♀, do. (H. M.); 7. B. rajellus *K.* ♀, not so frequent, do. (H. M.); 8. B. sylvarum *L.* ♀, do. (H. M.); 9. B. terrester *L.* ♀, perforating the flowers, though able to suck legitimately (H. M.); 10. Xylocopa violacea *L.* ♂ (H. M., Strassburg).

The following were recorded by the observers, and for the localities stated.—

Knuth (Schleswig-Holstein), 3 humble-bees at the same time—1. B. agrorum *F.* ♀, skg. legitimately; 2. B. hortorum *L.* ♀, do.; 3. B. terrester *L.* ♀, perforating the flowers and stealing nectar. Schulz, flowers perforated by humble-bees. Wüstnei (Alsen), the humble-bee Bombus agrorum *F.*, skg. Alfken (Bremen), 7 bees—1. Apis mellifica *L.* ☿, skg.; 2. Bombus agrorum *F.* ♀, very common, skg. and po-cltg.; 3. B. derhamellus *K.* ♀ and ☿, do.; 4. B. jonellus *K.* ♀ and ☿, do.; 5. B. hortorum *L.* ♀, skg.; 6. B. lapidarius *L.* ♀, do.; 7. B. muscorum *F.* ♀, do. Herm. Müller (Alps), 2 humble-bees. MacLeod (Flanders), 3 humble-bees (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 368). Loew (Berlin Botanic Garden), the honey-bee, vainly skg., its head and thorax dusted with pollen.

723. **Moluccella** L.

Flower mechanism as in Lamium. The calyx is modified into an extremely large protecting roof.

2321. M. laevis L. (Knuth, Bot. Centralbl., Cassel, lxxii, 1897.)—This Syrian species bears homogamous humble-bee flowers. The mechanism of those cultivated in the Kiel Botanic Garden closely agrees with Lamium, but differs from all our native Labiatae in the excessive development of the calyx. This forms a slightly

oblique funnel, $2\frac{1}{2}$–3 cm. long, 2–$2\frac{1}{2}$ cm. in diameter at the top, and about $2\frac{1}{2}$ cm. deep. Its margin is beset with five small spines. The other parts of the flower are thus well protected from rain, injurious insects, and perforating nectar-thieves.

The arched upper lip, slightly cleft in the middle, is pale pink outside, and brighter pink inside; its length is about the same as that of the longer stamens, so that only the extreme tips of the anthers of these project beyond it. The lower lip is of considerable length (12–13 mm.), and lies on the lower, inner surface of the calyx, which provides the necessary foothold for insect visitors. The large yellowish-white central lobe of the lower lip is rather deeply cleft, and provided with a longitudinal median groove, which is prolonged into the nectar-bearing base of the flower. The lateral lobes are small and triangular. Both lips are marked internally with dark rose-coloured nectar-guides.

The corolla-tube is 8 mm. long, so that only long-tongued humble-bees can suck all the nectar secreted by the base of the ovary. It is further protected by

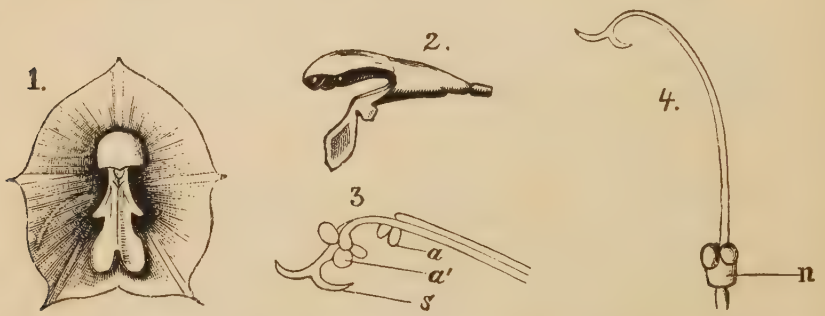


FIG. 335. *Molucella laevis*, *L.* (from nature). (1) Flower seen from the front. (2) Do., from the side, after removal from the calyx. (Natural size.) (3) Tips of the reproductive organs, from the side: *a* and *a'*, anthers of the shorter and longer stamens; *s*, stigma (× 3). (4) The pistil: *n*, nectary (× $2\frac{1}{2}$).

a gibbosity 3 mm. from the bottom of the corolla-tube, from which a fold of membrane runs inwards to serve as a nectar-cover.

The flowers are homogamous. The stigma is situated between the anthers of the two longer stamens, frequently projecting far beyond them, and the two stigmatic branches curve away from each other above and below. The lower branch is first touched by an insect visitor and dusted with foreign pollen, the upper side of the proboscis or the head of the visitor being then sprinkled with fresh pollen. Should insect-visits fail, automatic self-pollination by the longer stamens is effected.

VISITORS.—Knuth (Kiel Botanic Garden, 26. 8. '97) observed 2 humble-bees with proboscis long enough to suck all the nectar—Bombus agrorum *F.* ♂ (prob. 10–11 mm.), and B. lapidarius *L.* ♂ (prob. 8–10 mm.).

724. Galeopsis L.

Homogamous, rarely feebly protandrous bee flowers. The galeate upper lip serves as a protecting roof for the anthers in bad weather, while the lower lip forms a platform and possesses two lateral, hollow teeth which guide the head of a bee visitor. As usual the base of the ovary serves as a nectary, which broadens consider-

ably in front. The secretion is sheltered in the lowest part of the corolla-tube. Each anther-lobe dehisces by a single valve. Kerner describes the lobes as resembling boxes provided with covers, which spring open when touched so that pollen falls out. This, however, can only be effected by bees of a size corresponding to the dimensions of the flowers, and it is only these that get their backs dusted with pollen. Gynomonoecism occasional, gynodioecism rare.

2322. G. sp.—

Visitors.—Schneider (corn-fields in Arctic Norway) observed 2 humble-bees—Bombus agrorum *F.*, and B. scrimshiranus *K.* (Mus. Aarsh. Tromsø, xvii, 1895).

2323. G. Tetrahit L. (Herm. Müller, 'Fertilisation,' pp. 491–2, 'Alpenblumen,' p. 312, 'Weit. Beob.,' III, p. 48; Schulz, 'Beiträge,' II, p. 197; Kirchner, 'Flora v. Stuttgart,' p. 624; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 356; Loew, 'Blütenbiol. Floristik,' p. 395; Knuth, 'Bloemenbiol. Bijdragen'; Möwes, Bot. Jahrb., Leipzig, iv, 1883.)—In this species the bright-purple corolla possesses a nectar-guide on the lower lip in the form of a yellow spot traversed by a network of

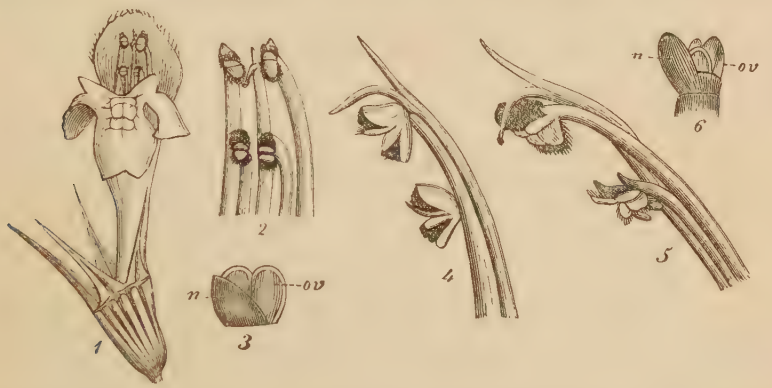


Fig. 336. *Galeopsis Tetrahit, L.*, and *G. ochroleuca, Lam.* (after Herm. Müller). (1–3) *G. Tetrahit.* (1) Flowers seen from the front. (2) Reproductive organs of do., seen from the front, and further enlarged (× 7). (3) Ovary (*ov*) and nectary (*n*) of do. (× 7). (4–6) *G. ochroleuca.* (4) Relative position of the reproductive organs at the beginning of anthesis. (5) Do. at the end of anthesis. (6) Ovary (*ov*) and nectary (*n*).

red lines. The corolla-tube, directed obliquely upward, varies between 11 and 17 mm. in length. Its uppermost 4–6 mm. are so enlarged that a small humble-bee can insert the whole, and a middle-sized or large one the fore-part of its head. The larger humble-bees, therefore, must have a proboscis 14–15 mm. long in order to suck all the nectar; smaller ones can do so with a proboscis of 12 mm. The anthers dehisce shortly before the beginning of anthesis, turning their pollen-covered surfaces downwards. The two stigmatic branches are at first situated slightly above and behind the anthers, so that a humble-bee visitor touches the latter sooner than the tip of the lower stigmatic branches; this is usually, however, with a different part of its head, hence cross-pollination is generally effected. Later on the tip of the style bends slightly downwards, so that the lower branch projects between the anthers, and if the pollen has not been removed by insects, some of it falls on the stigma, effecting automatic self-pollination. Short-tongued humble-bees obtain the nectar by perforation.

Besides hermaphrodite flowers, Schulz observed sporadic female ones, generally growing on the same stocks as the former, though more rarely gynodioeciously distributed. Female flowers seem to occur more frequently in the South than in the North. Möwes also often found flowers with partially or entirely reduced stamens.

Visitors.—Alfken observed 7 humble-bees, skg., and Höppner 12 bees, at Bremen.—

Alfken—1. Bombus agrorum *F.* ☿; 2. B. arenicola *Ths.* ☿; 3. B. derhamellus *K.* ☿; 4. B. distinguendus *Mor.* ♀, ☿, and ♂; 5. B. lapidarius *L.* ☿; 6. B. sylvarum *L.* ♀; 7. B. terrester *L.* ☿. Höppner—1. Andrena convexiuscula *K.* ♀; 2. Apis mellifica *L.* ☿; 3. Bombus arenicola *Ths.* ♀ and ☿; 4. B. distinguendus *Mor.* ♀, ☿, and ♂; 5. B. hortorum *L.* ♀; 6. B. lapidarius *L.* ☿; 7. B. muscorum *F.* ♀ and ☿; 8. B. rajellus *K.* ♀, ☿, and ♂; 9. B. sylvarum *L.* ♀ and ☿; 10. B. variabilis *Schmiedekn.* ☿; 11. Podalirius borealis *Mor.* ♂; 12. P. retusus *L.* ♀ and ♂.

Herm. Müller (H. M.) and Borgstette (Borg.) give the following list.—

A. Diptera. *Syrphidae*: 1. Melanostoma mellina *L.*, po-dvg. (H. M.). **B. Hymenoptera.** *Apidae*: 2. Andrena coitana *K.* ♀ (Borg.); 3. Bombus agrorum *F.* ♀, skg. (H. M.); 4. B. hortorum *L.* ♀, in large numbers, do. (H. M.); 5. B. scrimshiranus *K.* ♂, skg. (H. M.); 6. B. sylvarum *L.* ☿, do. (H. M.); 7. B. terrester *L.* ♀, obtaining nectar by perforation (H. M.). **C. Lepidoptera.** *Rhopalocera*: 8. Pieris rapae *L.*, skg., in large numbers (H. M.).

The following were recorded by the observers, and for the localities stated.—

Knuth, the humble-bee Bombus agrorum *F.*, skg. Loew (Riesengebirge), do. ☿, po-cltg. Schulz, perforation by humble-bees. Herm. Müller (Alps), 6 humble-bees. Hoffer (Steiermark), 2 humble-bees—Bombus argillaceus *Scop.* ♀ and ☿, and B. mastrucatus *Gerst.* MacLeod (Pyrenees), 2 humble-bees, skg. legitimately (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 332): (Flanders), a humble-bee, 2 hover-flies, and a Muscid (op. cit. vi, 1894, p. 372). Willis (neighbourhood of S. coast of Scotland), 2 humble-bees—Bombus agrorum *F.*, skg., and B. terrester *L.*, freq., do. ('Fls. and Insects in Gt. Britain,' Part I). Scott-Elliot (Dumfriesshire), 4 humble-bees and 2 hover-flies ('Flora of Dumfriesshire,' p. 139).

2324. G. ochroleuca Lam. (Herm. Müller, 'Fertilisation,' pp. 492–3, 'Weit. Beob.,' III, p. 48; Schulz, 'Beiträge,' II, pp. 138–9, 221; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 356; Knuth, 'Bloemenbiol. Bijdragen.')—The flowers of this species are yellowish-white in colour, with a yellow nectar-guide on the lower lip. Their mechanism agrees essentially with that of G. Tetrahit (cf. Fig. 336, 4–6), but the corolla-tube is 18–20 mm. long, the upper 6–7 mm. being so dilated that a humble-bee can insert its head with ease, and a proboscis of 11–14 mm. long is then able to suck all the nectar. The stigmatic branches project beyond the anthers of the longer stamens, so that a humble-bee probing for nectar must always touch the lower one first and bring about cross-pollination. Should insect-visits fail, automatic self-pollination is ensured towards the end of anthesis by the bending of the lower stigmatic branch until it comes below the anterior anthers, when it is dusted by the falling pollen. Hermann Müller says that the nectary is larger than that of G. Tetrahit, enclosing the lower part of the two posterior sections of the ovary, and projecting considerably beyond the two anterior. Kerner describes the flower as protandrous.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth, the humble-bee Bombus agrorum *F.*, skg. Schulz, perforated flowers, Herm. Müller (H. M.) and Buddeberg (Budd.), 3 bees—1. Bombus agrorum *F.* ♀, in large numbers, skg. (H. M.); 2. B. hortorum *L.* ♀, occasional, skg. (H. M.); 3. Rhophites quinquespinosus *Spin.* ♂, creeping right into the flowers to suck (Budd.). Alfken (Bremen), 2 humble-bees, skg.—Bombus hortorum *L.* ♀ and ♂, and B. ruderatus *F.* ☿ and ♂. Höppner (Bremen), 3 humble-bees—1. Bombus arenicola *Thoms.* ♀; 2. B. lapidarius *L.* ♀; 3. Podalirius retusus *L.* ♀.

2325. G. Ladanum L. (Herm. Müller, 'Fertilisation,' p. 493, 'Weit. Beob.,' III, p. 48, 'Alpenblumen,' p. 312; Schulz, 'Beiträge,' II, pp. 197, 221; Kirchner, 'Flora v. Stuttgart,' p. 625; Knuth, 'Bloemenbiol. Bijdragen,' 'Blütenbiol. Herbstbeob.') —In this species the corolla is purple-red, with a yellow spot dotted with red on the lower lip, and a tube 11–16 mm. long, the wider part at the top being 5-6 mm. in length. As in G. ochroleuca, the stigmatic branches project beyond the longer stamens, so that the lower, downwardly directed branch is always first brushed against by the back of the humble-bee visitor at the beginning of anthesis, cross-pollination being thus ensured. Towards the end of anthesis the tip of this stigmatic branch bends so far back that it is brought under the anthers of the longer stamens. Should insect visits fail, therefore, automatic self-pollination is possible as a last resort; otherwise the flower-mechanism agrees with that of G. Tetrahit.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth, 2 humble-bees—Bombus agrorum *F.*, and B. lapidarius *L.*, skg. Herm. Müller (H. M.) and Buddeberg (Budd.).—**A. Diptera.** *Bombyliidae*: 1. Bombylius canescens *Mik.*, skg. (Budd.). **B. Hymenoptera.** *Apidae*: 2. Bombus agrorum *F.* ♀, skg. (H. M.); 3. B. lapidarius *L.* ♂, skg. (H. M.); 4. B. sylvarum *L.* ♀, skg. (H. M., Budd.); 5. Nomada jacobaeae *Pz.* ♀, skg. (H. M.). **C. Lepidoptera.** *Rhopalocera*: 6. Pieris brassicae *L.*, skg. (Budd.). Schenck (Nassau), the elegant bee Podalirius bimaculatus *Pz.*, loudly humming. Hoffer (Steiermark), the humble-bee Bombus argillaceus *Scop.* ♀ and ☿. Herm. Müller (Alps), 4 bees and 3 Lepidoptera. MacLeod (Pyrenees), the humble-bee Bombus hortorum *L.* ♂, skg. legitimately (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 332).

Schulz found the variety *angustifolia* Ehrh. with female flowers (usually not more than 5 % in number) distributed gynomonoeciously, rarely and sporadically gynodioeciously. He, like Hermann Müller, describes the hermaphrodite flowers as homogamous or sometimes feebly protandrous, varying greatly in size, and often perforated.

Schulz, in rare instances, noticed female flowers on the variety *latifolia* Hoffm. Their distribution was gynomonoecious, rarely gynodioecious. These flowers also vary greatly in size, and were found by Schulz to be homogamous or feebly protandrous.

2326. G. versicolor Curt. (=G. speciosa *Mill.*). (Axell, 'Om Anord. för Fanerog. Växt. Befrukt.,' p. 18; Herm. Müller, 'Fertilisation,' p. 493; Kirchner, 'Flora v. Stuttgart,' p. 624; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Knuth, 'Bloemenbiol. Bijdragen.')—In this species the bright yellow corolla possesses a conspicuous dark-violet nectar-guide in front; the lower lip is yellow at the base. The corolla-tube is 18–22 mm. long, and expands for 6–8 mm. above, so that a proboscis of 12–16 mm. long is necessary to reach the nectar-bearing base of the flower. As

the tube is filled to a depth of 2–3 mm. with the secretion, a humble-bee with a proboscis 10 mm. long can just reach it, but not suck it all. Warnstorf describes the pollen-grains as of a beautiful yellow colour, ellipsoidal, very delicately tuberculate, about 56 μ long and 28 μ broad.

Axell says that self-pollination is effective.

Schulz observed perforated flowers.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth, 2 humble-bees, skg.—Bombus hortorum *L.* (proboscis 19–21 mm.), and B. agrorum *F.* ♀ (prob. 15 mm.). Schulz (Bozen), the former humble-bee, and the hawk-moth Macroglossa stellatarum *L.*, skg. legitimately. Alfken (Bremen), 3 humble-bees, skg.—1. Bombus hortorum *L.* ♀; 2. B. ruderatus *F.* ♀; 3. B. terrester *L.* ♀.

2327. G. pubescens Bess. (=G. Tetrahit *L.*, according to the *Index Kewensis*). (Schulz, 'Beiträge,' II, p. 197.)—In this species Schulz observed occasional female flowers, distributed gynomonoeciously, as well as feebly protandrous hermaphrodite ones.

725. Stachys L.

Usually protandrous, more rarely homogamous bee flowers. Nectar is almost always secreted (but not in S. arvensis *L.*, according to Kirchner), as usual, by the base of the ovary; it is stored in the smooth, lowest part of the corolla-tube. The upper lip not only shelters the anthers and stigma in bad weather, but also protects the nectar from rain. A circlet of hairs inside the corolla-tube just above the base also serves this purpose, and keeps away unbidden guests, such as flies and so forth. The lower lip again forms a convenient platform; it is generally provided with a nectar-guide.

2328. S. sylvatica L. (Sprengel, 'Entd. Geh.,' p. 307; Herm. Müller, 'Fertilisation,' pp. 486–7, 'Weit. Beob.,' III, p. 48; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 272–3; Schulz, 'Beiträge,' II; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 356; Loew, 'Blütenbiol. Floristik,' p. 395; Knuth, 'Blütenbiol. Herbstbeob.'; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Kirchner, 'Flora v. Stuttgart,' pp. 625–6.)—In this species the large, three-lobed lower lip of the red flower possesses a purple and white design serving as a nectar-guide. The upper lip is somewhat small, but it covers the anthers and stigma as the flower is almost horizontal. The corolla-tube is 10–11 mm. long, its lowest 2–3 mm. being filled with nectar. The flowers are protandrous. At first the tip of the style, with almost apposed branches, is situated behind the anthers, which have dehisced downwards. Later on it bends down under the anthers, at the same time opening its branches widely. When visited by a humble-bee, therefore, cross-pollination is ensured. The stigma of older flowers is dusted with pollen from younger ones. If insect-visits fail, automatic self-pollination is brought about, the stigmatic branches sliding gradually between the anthers, which are still covered with pollen. Kerner says that it is effected by the two stigmatic branches bending downwards until they touch the anthers. Warnstorf describes the pollen-grains as white in colour, ellipsoidal, bent, with small tubercles, up to 43 μ long and 20–25 μ broad.

The flowers are frequently perforated by short-tongued humble-bees.

Visitors.—Herm. Müller (H. M.) and Buddeberg (Budd.) give the following list.—

A. Diptera. *Syrphidae*: 1. Rhingia rostrata *L.*, skg. (H. M.); 2. Xylota sylvarum *L.*, vainly searching for nectar (H. M.). **B. Hymenoptera.** 3. Anthidium manicatum *L.* ♀ and ♂, freq., skg. (H. M., Budd.); 4. Anthophora furcata *Pz.* ♀ and ♂, less freq., skg. (H. M., Thuringia); 5. A. quadrimaculata *Pz.* ♀ and ♂, freq., skg. (H. M.); 6. Bombus agrorum *F.* ☿ and ♀, do. (H. M.); 7. B. hortorum *L.* ♂, skg. (H. M.); 8. B. pratorum *L.* ☿ and ♂, skg. (H. M.).

Alfken observed 10 bees, skg., at Bremen.—

1. Anthidium manicatum *L.* ♀ and ♂; 2. Bombus agrorum *F.* ☿; 3. B. derhamellus *K.* ♀; 4. B. lapidarius *L.* ♀; 5. B. sylvarum *L.* ♀; 6. Osmia caerulescens *L.* ♀; 7. O. rufa *L.* ♀; 8. Podalirius borealis *Mor.* ♀ and ♂; 9. B. furcatus *L.* ♀ and ♂; 10. P. vulpinus *Pz.* ♀ and ♂.

The following were recorded by the observers, and for the localities stated.—

Knuth (Schleswig-Holstein), 2 humble-bees (Bombus agrorum *F.* and B. hortorum *L.*, skg.) and 2 po-dvg. hover-flies (Eristalis tenax *L.*, and Platycheirus sp.). Wüstnei (Alsen), the bee Anthophora quadrimaculata *F.* Loew, Brunswick (B.), and Steiermark (S.), 2 bees ('Beiträge,' p. 53)—Anthidium manicatum *L.* ♀ (B.) and Bombus agrorum *F.* ☿, skg. (S.): (Berlin Botanic Garden), the bee Anthidium manicatum *L.* ♀ and ♂, skg., and *in copula*. Höppner (Bremen), 4 bees—1. Apis mellifica *L.*; 2. Andrena convexiuscula *K.* ♀; 3. Bombus arenicola *Ths.* ♀ and ☿; 4. Podalirius retusus *L.* ♀. Rössler (Wiesbaden), 2 moths—Penthina fuligana *Hb.*, and Botys stachydalis *Zk.* Friese (Baden and Thuringia), the bee Podalirius furcatus *Pz.*, one ♂. Heinsius (Holland), 3 bees, skg.—1. Bombus agrorum *F.* ☿; 2. B. hortorum *L.* ♂; 3. Apis mellifica *L.* ☿ (Bot. Jaarb. Dodonaea, Ghent, iv, 1892, pp. 111–13). MacLeod (Flanders), 4 long-tongued bees and a Lepidopterid (op. cit., v, 1893, p. 373): (Pyrenees), the humble-bee Bombus alticola *Krchb.* ☿ (op. cit., iii, 1891, p. 332). Scott-Elliot (Dumfriesshire), 3 humble-bees and a hover-fly ('Flora of Dumfriesshire,' p. 138).

2329. S. palustris L. (Sprengel, 'Entd. Geh.,' p. 308; Delpino, 'Ult. oss.,' p. 149; Herm. Müller, 'Fertilisation,' p. 487, 'Weit. Beob.,' III, p. 49; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 118, 166, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 239, 'Bloemenbiol. Bijdragen'; Verhoeff, 'Bl. u. Insekt. a. d. Ins. Norderney'; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 373–4; Schulz, 'Beiträge,' II, p. 221; Kirchner, 'Flora v. Stuttgart,' p. 626.)—In this species the lower lip of the bright-purple corolla is marked with a whitish and dark-red patch. The corolla-tube being only 8–9 mm. long, all our native humble-bees (including B. terrester *L.* with proboscis 7–9 mm. long) can suck nectar legitimately. The four stamens are of equal length. The anthers of the outer stamens are situated at first in front of those of the inner ones, and dehisce first. Then they bend outwards and are separated from the dehiscing inner ones. Finally, the tip of the style grows downwards between the latter, the stigmatic branches diverging at the same time. Automatic self-pollination is therefore easily possible should insect-visits fail. Kerner says that this is effected in the same way as in the preceding species. Warnstorf describes the pollen-grains as white in colour, ellipsoidal, closely beset with small tubercles, about 44–7 μ long and and 25–31 μ broad.

Schulz says that Bombus terrester *L.* frequently obtains nectar by perforation, in spite of the fact that its proboscis is long enough to suck legitimately.

Visitors.—Herm. Müller (H. M.) and Buddeberg (Budd.) give the following list.—

A. Diptera. *Syrphidae*: 1. Melithreptus taeniatus *Mg.*, po-dvg. (H. M.); 2. Rhingia rostrata *L.*, skg., and occasionally effecting pollination (H. M.). **B. Hymenoptera.** *Apidae*: 3. Bombus agrorum *F.* ♀, in large numbers, skg. (H. M.); 4. B. sylvarum *L.* ☿, skg. legitimately (H. M.); 5. B. terrester *L.* ☿, do. (H. M.); 6. B. tristis *Seidl.* ♀, skg. (Budd.); 7. Saropoda bimaculata *Pz.*, freq., skg. (Budd.). **C. Lepidoptera.** (*a*) *Rhopalocera*: 8. Pieris brassicae *L.*, freq., skg. (H. M.); 9. P. rapae *L.*, do. (H. M.). (*b*) *Noctuidae*: 10. Plusia gamma *L.*, freq., skg. (H. M.).

Alfken observed the following at Bremen.—

A. Diptera. (*a*) *Muscidae*: 1. Echinomyia tessellata *F.* (*b*) *Syrphidae*: 2. Rhingia rostrata *L.* **B. Hymenoptera.** *Apidae*: 3. Anthidium manicatum *L.* ♀ and ♂; 4. Bombus agrorum *F.* ♀, ☿, and ♂; 5. B. arenicola *Ths.* ♂; 6. B. distinguendus *Mor.* ♀ and ☿, skg.; 7. B. hortorum *L.* ☿, skg.; 8. B. lapidarius *L.* ☿; 9. B. lucorum *L.* ☿; 10. B. pomorum *Pz.* ☿; 11. B. proteus *Gerst.* ☿ and ♂; 12. B. ruderatus *F.* ♂, skg.; 13. B. sylvarum *L.* ☿ and ♂; 14. Megachile ligniseca *K.* ♀; 15. Podalirius borealis *Mor.* ♀ and ♂; 16. P. furcatus *L.* ♀ and ♂; 17. P. vulpinus *Pz.* ♀ and ♂.

Willis noticed the following in the neighbourhood of the S. coast of Scotland ('Fls. and Insects in Gt. Britain,' Part I).—

A. Coleoptera. *Nitidulidae*: 1. Meligethes sp., freq., po-dvg. **B. Diptera.** (*a*) *Muscidae*: 2. Anthomyia radicum *L.*, freq., po-dvg. (*b*) *Syrphidae*: 3. Melanostoma scalare *F.*, po-dvg; 4. Platycheirus albimanus *F.*, freq., skg. and po-dvg. **C. Hemiptera.** 5. Anthocoris sp. **D. Hymenoptera.** *Apidae*: 6. Anthidium manicatum *L.*, skg.; 7. Bombus agrorum *F.*, very common, skg.; 8. B. hortorum *L.*, do.; 9. B. terrester *L.*, do.

The following were recorded by the observers, and for the localities stated.—

Knuth (Rügen), the humble-bee Bombus agrorum *F.* ♀, skg.: (Helgoland), the bee Anthophora quadrimaculata *Pz.* ♂ (Bot. Jaarb. Dodonaea, Ghent, viii, 1896, p. 44): (N. Frisian Is. and E. Holstein), 7 long-tongued bees, a true wasp, 5 Lepidoptera, and 4 hover-flies. Verhoeff (Norderney), a hover-fly (Syrphus corollae *F.*, po-dvg.), a humble-bee (Bombus hortorum *L.* ♂, skg.), and a Noctuid moth (Plusia gamma *L.*, skg.). Alfken (Juist), 4 humble-bees—1. Bombus hortorum *L.* ☿, skg.; 2. B. muscorum *F.* ☿, do.; 3. B. ruderatus *F.* ☿, do.; 4. B. terrester *L.* ☿, do. Friese (Mecklenburg), the bee Podalirius furcatus *Pz.* Schulz, the humble-bee Bombus terrester *L.*, skg. legitimately, and also as a nectar-thief. Hoffer (Steiermark), the humble-bee Bombus rajellus *K.* Scott-Elliot (Dumfriesshire), 3 humble-bees, one other long-tongued bee, 5 hover-flies, and a Muscid ('Flora of Dumfriesshire,' p. 139).

2330. S. arvensis L. (Kirchner, 'Beiträge,' pp. 56–7.)—The small, inconspicuous pale-red flowers of this species possess a nectar-guide on the lower lip in the form of dark spots, but there is little or no secretion of nectar. The individual flowers of the verticillasters grow in an almost horizontal position, and usually open one after another. The calyx is so deep that only the entrance of the corolla opens between its teeth. The arched upper lip is 2 mm. long, and stretches straight out so as at first to cover the anthers and stigma. The lower lip is 3 mm. long and possesses a gutter-shaped median groove. The corolla-tube is about 4 mm. long. At the beginning of anthesis, the anthers of the two inner stamens are twisted towards each other at the upper ends of their filaments, and dehisce on the surfaces

turning towards and touching each other. The two outer anthers turn their dehisced sides downwards. The style lies against the posterior wall of the corolla, and is so long, that the stigmatic branches, which mature simultaneously with the anthers, lie either close behind the two inner anthers, or slightly below them. Automatic self-pollination takes place in either case. Later on the two outer stamens diverge so far that their anthers project laterally between the upper and lower lips. The inner stamens diverge very little. The style next droops so far downwards that the stigma is brought into the mouth of the flower. Conditions are now favourable to cross-pollination, but insect-visits are so few that automatic self-pollination takes place with tolerable regularity.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Kirchner, the beetle Meligethes, and Thrips. Höppner (Bremen), 5 bees—1. Andrena convexiuscula *K.* ♀; 2. Apis; 3. Halictus calceatus *Scop.* ♀; 4. H. leucozonius *Schr.* ♀; 5. H. morio *F.* ♀.

2331. S. recta L. (Herm. Müller, 'Alpenblumen,' p. 312, 'Weit. Beob.,' III, pp. 49–50; Loew, 'Blütenbiol. Floristik,' pp. 392, 395; Kirchner, 'Flora v. Stuttgart,' p. 627; Schulz, 'Beiträge,' II, p. 197.)—The yellowish-white flowers of this species possess nectar-guides in the form of two longitudinal purple lines each side of the margin of the upper lip, and several rows of purple spots on the lower lip. Nectar is abundantly secreted by the large, fleshy base of the ovary, and concealed at the bottom of the corolla-tube. This is 7–8 mm. long, and its lower part is directed obliquely upward: a circlet of stiff hairs protects the nectar. The upper, wider part of the corolla-tube bends slightly outwards, thus taking the form which affords the most convenient position for sucking to the proboscis of a humble-bee.

The flowers are strongly protandrous. The anthers of the two shorter stamens mature first, turning their pollen-covered surfaces downwards, so that a bee probing for nectar must brush against them with its back. They subsequently turn outwards and downwards, and are replaced by the two longer ones, which now expose their pollen-covered surfaces to visitors below the middle of the upper lip. The style elongates when these are shrivelled, so that the diverging stigmatic branches assume the position previously occupied by the anthers. When visited by insects, therefore, cross-pollination is ensured. Automatic self-pollination is excluded.

Warnstorf describes the pollen-grains as white in colour, globular when examined in water, smooth, transparent, with very finely granular contents and delicately striated, 37·5 to 45 μ in diameter.

Visitors.—Schletterer either gives the following bees for the Tyrol (T.) or observed them at Pola (P.).

1. Anthidium manicatum *L.* (T. and P.); 2. A. septemdentatum *Ltr.*; 3. Andrena convexiuscula *K.*, var. fuscata *K.*; 4. B. sylvarum *L.* (T.); 5. B. terrester *L.*; 6. B. variabilis *Schmiedekn.* (T.); 7. Coelioxys aurolimbata *Först.*; 8. C. conoidea *Ill.*; 9. C. rufocaudata *Sm.*; 10. Eucera (Macrocera), alternans *Brull.*; 11. E. interrupta *Baer.*; 12. Halictus albipes *F.* (T.); 13. Megachile ericetorum *Lep.*; 14. M. lefeburei *Lep.*; 15. M. muraria *Retz.*

The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Thuringia), 2 bees, skg.—Apis mellifica *L.* ☿, and Megachile

centuncularis *L.* ♂ (Alps), 2 humble-bees, skg. Loew (Mecklenburg and the Harz) ('Beiträge,' pp. 45, 53), the bee Anthidium manicatum *L.* ♂, skg. Friese (Hungary), the bee Halictus (Nomioides) pulchellus *Schenck*, freq.: (Thuringia), the parasitic bee Stelis nasuta *Ltr.* MacLeod (Pyrenees), 2 humble-bees and a Lepidopterid (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 332). Loew (Berlin Botanic Garden), the hover-fly Melithreptus scriptus *L.*, po-dvg., and 3 bees—1. Anthidium manicatum *L.* ♀ and ♂, skg., also *in copula*; 2. Bombus agrorum *F.* ♀, skg.; 3. B. sylvarum *L.* ♀, skg. Gerstäcker (Berlin), 4 bees—1. Coelioxys afra *Lep.*, one ♂; 2. C. elongata *Lep.*, one ♀; 3. C. quadridentata *L.*; 4. Osmia aurulenta *Pz.*, freq. von Dalla Torre (Tyrol), 4 bees—1. Anthidium manicatum *L.* ♂; 2. Bombus muscorum *F.* ☿, very common; 3. B. sylvarum *L.* ♀ and ☿; 4. B. variabilis *Schmiedekn.* (=B. tristis *Seidl.*) ♀.

2332. S. annua L. (Schulz, 'Beiträge,' I, p. 84, II, pp. 138–9; Kirchner, 'Beiträge,' p. 56.)—The flowers of this species are whitish-yellow, the lower lip being spotted with red. Schulz says that the corolla-tube is 8–10 mm. long, and its mouth 5–6 mm. wide. The stigmatic branches often diverge in the bud, and the anthers dehisce after the opening of the flower. They are situated so close to the stigma that automatic self-pollination must take place. The outer stamens subsequently bend outwards. Self-pollination can be effected by insect-visits as easily as cross-pollination. Purely female flowers have not been observed.

Visitors.—Kirchner observed humble-bees, but did not determine their species.

2333. S. italica Mill.—

Visitors.—Schletterer observed the following 7 bees at Pola.—

1. Anthidium manicatum *L.*; 2. Andrena cyanescens *Nyl.*; 3. Bombus terrester *L.*; 4. Megachile argentata *F.*; 5. M. bicoloriventris *Mors.*; 6. M. lefeburei *Lep.*; 7. M. muraria *Retz.*

2334. S. germanica L. (Schulz, 'Beiträge,' II, p. 197; Kirchner, 'Flora v. Stuttgart,' p. 628; Knuth, 'Bloemenbiol. Bijdragen.')—This species bears female flowers, as well as protandrous hermaphrodite ones. Schulz only observed occasional gynomonoecism. T. Whitelegge says that gynodioeciously distributed female flowers occur in England. Kirchner also describes the plant as gynodioecious (in Wurtemberg) and the female stocks as bearing small flowers with stamens entirely absent or greatly reduced.

Visitors.—Loew observed the following bees in the Berlin Botanic Garden.—

1. Anthidium manicatum *L.* ♂ and ♀, skg.; one ♀ was seen biting off the felted white hairs from the leaves with her mandibles; 2. Apis mellifica *L.* ☿, skg.; 3. Bombus agrorum *F.* ☿, do.; 4. B. terrester *L.* ♂, do.; 5. Megachile fasciata *Sm.* ♂, do.; 6. Psithyrus vestalis *Fourcr.* ♀, do.: on the var. *dasyantha* Bombus lapidarius *L.* ☿, skg.: on the var. *intermedia* Ait.—Coelioxys rufescens *Lep.* ♂, skg.: on the var. *villosa* Anthidium manicatum *L.*, skg., and Megachile fasciata *Sm.* ♂, do.

The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel Botanic Garden), the humble-bee Bombus terrester *L.* ♀, skg. Schletterer and von Dalla Torre (Tyrol), the bee Megachile muraria *Retz.*

2335. S. alpina L.—

Visitors.—Loew (Berlin Botanic Garden) observed the honey-bee, skg.

2336. S. cretica Sibth. et Sm.—

Visitors.—Loew (Berlin Botanic Garden) observed 3 bees, skg.—

1. Anthidium manicatum *L.* ♂ and ♀; 2. Bombus lapidarius *L.* ☿; 3. Megachile fasciata *Sm.* ♂.

2337. S. lanata Jacq.—

Visitors.—Loew (Berlin Botanic Garden) observed 5 bees, skg.—

1. Anthidium manicatum *L.* ♂ and ♀; 2. Bombus terrester *L.* ☿; 3. Coelioxys rufescens *Lep.* ♀; 4. Megachile fasciata *Sm.* ♂; 5. M. willughbiella *K.* ♂.

2338. S. longespicata Boiss. et Kotschy.—

Visitors.—Loew (Berlin Botanic Garden) observed 2 bees, skg.—Anthidium manicatum *L.* ♀, and Bombus agrorum *F.* ♂.

2339. S. ramosissima Rochel.—

Visitors.—Loew (Berlin Botanic Garden) observed the bee Anthidium manicatum *L.* ♀.

2340. S. setifera C. A. Mey. (= S. recta *L.*, according to the *Index Kewensis*).—

Visitors.—As the last species.

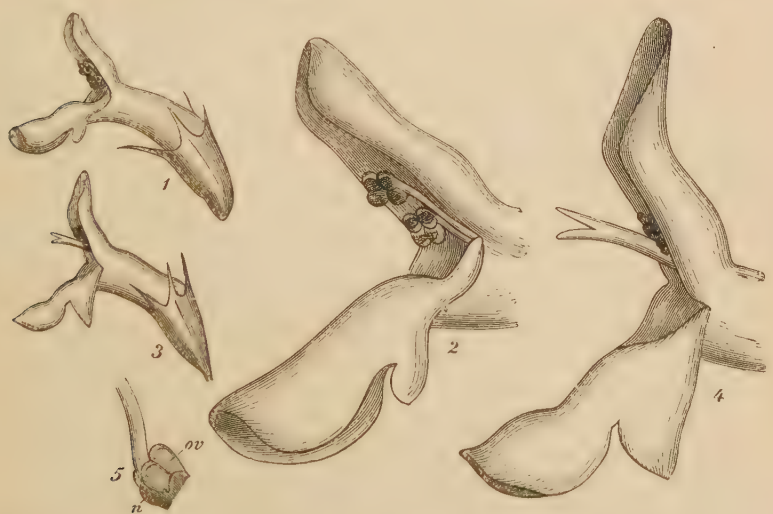


Fig. 337. *Stachys Betonica, Benth.* (after Herm. Müller). (1) Flower in the first (male) stage, seen from the side (× 2½). (2) Front part of do., more strongly magnified (× 7). (3) Flower in the second (female) stage, seen from the side (× 2½). (4) Front part of do., more strongly magnified. (5) Ovary (*ov*) and nectary (*n*). (× 7.)

2341. S. Betonica Benth. (= Betonica officinalis *L.*). (Herm. Müller, 'Fertilisation,' pp. 487–8, 'Weit. Beob.,' III, p. 50; Schulz, 'Beiträge,' II, pp. 197, 222; Kirchner, 'Flora v. Stuttgart,' p. 629; Knuth, 'Bloemenbiol. Bijdragen.')—The corolla-tube of the fragrant, purple flowers of this species is 7 mm. long, and is not widened above, being so short that all our native humble-bees can suck all the nectar. Its curved shape corresponds to that of a humble-bee's proboscis. Its lower part is glabrous internally, but above that it is lined with erect hairs forming a nectar-cover. The anthers dehisce soon after the flower opens, the forked end of the style being situated between and behind the anthers of the two shorter stamens. The style then elongates, and projects from between the two shorter stamens, automatic self-

pollination being usually effected. Finally the stigma projects considerably beyond the anthers, so that an insect-visitor must brush against it before touching the latter. Hermann Müller, therefore, says that the flowers are protandrous; Schulz describes them as more or less protandrous to homogamous. The latter once observed a humble-bee perforating. Besides hermaphrodite flowers, Schulz observed quite sporadic female ones gynomonoeciously distributed.

Visitors.—Herm. Müller gives the following list.—

A. Diptera. *Syrphidae*: 1. Eristalis horticola *Mg.*, po-dvg.; 2. Volucella bombylans *L.*, do. **B. Hymenoptera.** *Apidae*: 3. Anthidium manicatum *L.*, ♀ and ♂, skg. (Würzburg); 4. A. oblongatum *Ltr.*, ♀ and ♂, do. (Würzburg); 5. Bombus agrorum *F.* ♀ and ☿, freq., skg.; 6. B. lapidarius *L.* ♀, skg. (Würzburg); 7. B. sp. ☿ (small, quite black), probably B. variabilis *Schmiedekn.*, do. (Würzburg); 8. Saropoda bimaculata *Pz.* ♀ and ♂, do. (Bavarian Oberpfalz). **C. Lepidoptera.** (*a*) *Rhopalocera*: 9. Epinephele hyperanthus *L.*, skg. (Kitzingen); 10. Hesperia comma *L.*, do. (Kitzingen); 11. Pieris sp., do. (Kitzingen). (*b*) *Sphingidae*: 12. Zygaena lonicerae *Esp.*, skg., in large numbers (Thuringia); 13. Z. meliloti *Esp.*, skg. (Kitzingen).

The following were recorded by the observers, and for the localities stated.—

Knuth, the humble-bee Bombus lapidarius *L.* ♀, skg. Wüstnei (Alsen), the bee Anthidium manicatum *L.* Schenck (Nassau), 6 bees—1. Anthidium manicatum *L.*; 2. Bombus agrorum *F.*; 3. B. confusus *Schenck* ☿ and ♂; 4. B. muscorum *F.* ☿ and ♂; 5. B. variabilis *Schmiedekn.* (=B. autumnalis *Schenck*); 6. Rophites quinquespinosus *Spin.* MacLeod (Pyrenees), the humble-bee Bombus hortorum *L.* ♂, skg. legitimately (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 332). Scott-Elliot (Dumfriesshire), 3 humble-bees ('Flora of Dumfriesshire,' p. 138).

2342. S. grandiflora Benth. (= Betonica grandiflora *Steph.*). (Loew, Ber. D. bot. Ges., Berlin, iv, 1886, pp. 117–19; Delpino, 'Ult. oss.,' pp. 144–6; Correns, Jahrb. wiss. Bot., Leipzig, lii, 1892.)—Loew describes this species as possessing a corolla-tube 22–25 mm. long, so that the nectar is inaccessible to all our native bees. The plant is interesting by reason of the presence of white spherules on the anthers, which are also to be found in Salvia verticillata *L.*, Marrubium, and Sideritis romana *L.* Delpino says that these little spherules contain a viscid substance, for the purpose of making the pollen cling more closely to an insect's proboscis. In this species such spherules are also found in small numbers on the papillose uneven upper surface of the anthers. They come under the category of epidermal glands, and consist of a short stalk-cell, and a gland-scale containing an oily fluid.

Correns examined the spherules on the anthers of Salvia officinalis and S. verticillata, and in 1892 expressed the opinion regarding their structure which Loew put forward in 1886. Both botanists consider them as ordinary glandular hairs, and as these (according to Correns) are found on the most various parts of flowers of the Salvia kind, even on those never touched by insect visitors, the opinion expressed by Delpino on their oecological significance is scarcely tenable.

Visitors.—Morawitz (Caucasus) saw the bee Rophites caucasicus *Mor.*, and Loew gives the following list for the Berlin Botanic Garden.—

A. Hymenoptera. *Apidae*: 1. Anthidium manicatum *L.* ♀, po-cltg., and vainly trying to suck; 2. Apis mellifica *L.* ☿, vainly skg.; 3. Prosopis communis *Nyl.* ♀, resting on the anthers and po-cltg. **B. Lepidoptera.** *Rhopalocera*: 4. Vanessa atalanta *L.*, skg.

2343. S. Alopecuros Benth. (=B. Alopecuros *L.*).—

Visitors.—Loew observed the bee Anthidium manicatum *L.* ♂, skg., in the Berlin Botanic Garden.

2344. S. densiflora Benth. (=B. hirsuta *L.*).—

Visitors.—As last species.

2345. B. orientalis *L.*—

Visitors.—Loew observed the humble-bee Bombus hortorum *L.* ☿, skg., in the Berlin Botanic Garden.

2346. S. densiflora (=B. rubicunda *Wender*).—

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Diptera. *Syrphidae*: 1. Syrphus balteatus *Deg.*, po-dvg. **B. Hymenoptera.** *Apidae*: 2. Anthidium manicatum *L.* ♂, skg.; 3. Bombus terrester *L.* ♂, do. **C. Lepidoptera.** *Rhopalocera*: 4. Pieris brassicae *L.*, skg.

726. Phlomis L.

Homogamous or protandrous bee flowers with a hinge-joint in the upper lip. Secretion and concealment of nectar as usual.

2347. P. tuberosa L. (Pammel, Trans. Acad. Sci., St. Louis (Mo.), v, 1888, pp. 241–77; Loew, 'Blütenbiol. Floristik,' p. 313.)—This species is indigenous to South-east Europe. Loew describes as follows the flower mechanism of plants cultivated in the Berlin Botanic Garden.—The bright-pink flowers possess a dark-red patch on the lower lip that serves as a nectar-guide. The corolla-tube is 9–11 mm. long, and almost entirely enclosed by the spiny-toothed calyx; inside it is a circlet of hairs. The hinge enabling the upper lip to be raised possesses a ventricose joint-swelling. If in a newly-opened flower this lip is pushed backwards, the elasticity of the hinge causes it to resume its original position. The elasticity subsequently becomes feebler, but the hinge remains flexible. The edge of the upper lip is dentate and thickly ciliate. At first only the lower and larger stigmatic branch projects through the closely-set hairs and teeth. Each of the two upper filaments is produced below its insertion into a curved process 4 mm. long. These processes are apparently supports; they lie on a keel-like ridge projecting into the corolla-tube, and act as buttresses to prevent its wall from collapsing, as might otherwise happen when a very heavy insect alighted on the lower lip. Pammel describes the flowers as protandrous, but those examined by Loew were homogamous.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Loew (Berlin Botanic Garden), humble-bees and bees with a proboscis 9–16 mm. long, i. e. Bombus agrorum *F.* ☿ (12–13 mm.), B. hortorum *L.* ☿ (14–16 mm.), and Anthidium manicatum *L.* (9–10 mm.). Pammel (North America), 3 species of humble-bee with a proboscis 11–16 mm. long. In spite, therefore, of the foreign origin of the plant, its flowers can be legitimately visited and crossed both in North America and North Germany by indigenous insects.

2348. P. viscosa Poir. (=P. Russeliana *Lag.*). (Loew, Ber. D. bot. Ges., Berlin, iv, 1886, pp. 113–17.)—Loew says that the flower mechanism of this species resembles that of P. tuberosa. The upper lip can be opened and shut by means of

a hinge-joint. After having been lifted up by a humble-bee probing for nectar in the base of the flower, the elasticity of the hinge causes it to resume its original position, once more closing the entrance of the corolla as soon as the insect leaves. A proboscis must be at least 16 mm. long in order to suck all the nectar, and even then the humble-bee is obliged to force its head into the upper part of the corolla-tube. To obtain it conveniently a proboscis 20 mm. long is necessary. Bombus hortorum *L.* ♀ (proboscis 19–21 mm.) can therefore suck easily, but the ☿ of this species (prob. 16 mm.) with some difficulty, as Loew was able to observe in the Berlin Botanic Garden. Bombus terrester *L.* tried in vain to lift the upper lip and reach the nectar.

Bombus hortorum *L.* is therefore our only native humble-bee which can suck all the nectar legitimately, and, in brushing first against the stigma and then against the anthers, effect crossing. All other insects are incapable of lifting the hinged upper lip. The flowers of the species are therefore *monotropous*, i. e. adapted solely to a single kind of pollinator.

Visitors.—Loew observed 2 bees in the Berlin Botanic Garden.—

1. Bombus hortorum *L.* ☿, raising the upper lip and skg.; 2. B. terrester *L.* ♀, vainly trying to raise the upper lip.

2349. P. armeniaca Willd.—

Visitors.—Loew observed 3 bees in the Berlin Botanic Garden.—

1. Anthidium manicatum *L.* ♂, skg.; 2. Bombus hortorum *L.* ♀, steadily skg.; 3. Osmia aenea *L.* ♀, skg.

2350. P. cashmiriana Royle.—

Visitors.—Loew (Berlin Botanic Garden) observed the humble-bee Bombus agrorum *F.* ♀, skg.

727. Sideritis Tourn.

2351. S. romana L. (Delpino, 'Ult. oss.,' pp. 144–6.)—The small, black-brown corolla of this species is supported by yellow bracts, and encloses the stamens and the very short style in its tube. Each of the two shorter of the four stamens possesses a crescent-shaped connective, which bears a fertile anther-lobe on one side and a sterile one on the other. The connectives are so placed that they form a complete ring round the nectar-passage. When an insect inserts its proboscis into this, it touches the pollen on the inside of the ring, and this adheres closely by means of viscid spherules (cf. the remark on Stachys grandiflora, p. 300). If the insect visits a second flower of this species, the pollen adhering to its proboscis will be scraped off against the cup-shaped stigma.

3352. S. montana L.—Kerner says that the flowers of this species agree with those of S. romana.

2353. S. hyssopifolia L.—

Visitors.—The following were recorded by the observers, and for the localities stated.—

MacLeod (Pyrenees), 5 humble-bees, a Lepidopterid, and a fly (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 333). Loew (Berlin Botanic Garden), the honey-bee and the humble-bee Bombus terrester *L.* ♂, skg.

2354. S. scordioides L.—

Visitors.—The following were recorded by the observers, and for the localities stated.—

Loew (Berlin Botanic Garden), 2 bees—Anthidium manicatum *L.* ♂, skg., and Bombus terrester *L.* ♂, skg. Knuth (Kiel Botanic Garden), 2 humble-bees—Bombus lapidarius *L.* ♀, and B. terrester *L.* ♀, both skg.

728. Marrubium Tourn.

Homogamous or feebly protandrous bee flowers, with stamens and style enclosed in the corolla-tube. Nectar secreted and concealed as usual. Delpino says that the anthers possess viscid spherules (cf. remark on Stachys grandiflora, p. 300). Sometimes gynodioecism.

2355. M. vulgare L. (Sprengel, 'Entd. Geh.,' p. 309; Herm. Müller, 'Weit. Beob.,' III, pp. 50–1; Kirchner, 'Flora v. Stuttgart,' p. 630.)—In this species the white corolla, which is devoid of nectar-guides, possesses a flat, cleft upper lip, the two lobes being directed vertically upward, and thus serving to increase the conspicuousness of the flower. The usual function of forming a shelter for stigma and anthers, and holding them in certain relative positions, is not here discharged by the upper lip, as they are enclosed in the corolla-tube. Nectar is secreted in the usual labiate manner, and a circlet of hairs in the corolla-tube serves as a nectar-cover. The tube is wider in the middle than above; the anthers are situated one pair behind the other on the upper side, and the simultaneously maturing stigma is placed below them. Cross-pollination is effected, although in probing for nectar a bee must touch the anthers first; but it removes very little pollen, as its proboscis depresses them still further, and they dehisce obliquely downwards. When the proboscis has touched the lower stigmatic branch and dusted the papillae of this with foreign pollen, it is sprinkled with fresh pollen as the bee backs out of the flower, for this movement causes the anthers to turn upwards. Should insect-visits fail, automatic self-pollination is effected by the falling of pollen on to the stigma situated below the anthers. Kerner says that purely female stocks also occur.

Bees are the only pollinators: other insects are unbidden guests.

Visitors.—Herm. Müller gives the following list.—

A. Coleoptera. *Nitidulidae*: 1. Meligethes sp., in the flowers (Thuringia). **B. Diptera.** *Empidae*: 2. Empis livida *L.*, skg. (Thuringia). **C. Hemiptera.** 3. A red sp. of bug, skg. (Bavarian Oberpfalz). **D. Hymenoptera.** (*a*) *Apidae*, 4. Anthidium manicatum *L.* ♂, skg. (Bavarian Oberpfalz); 5. Apis mellifica *L.* ☿, skg. (Thuringia and Bavarian Oberpfalz); 6. Coelioxys vectis *Curt.* (=C. punctata *Lep.*) ♀, skg. (Bavarian Oberpfalz); 7. Saropoda bimaculata *Pz.* ♂, skg. (Bavarian Oberpfalz). (*b*) *Chrysididae*: 8. Hedychrum lucidulum *Ltr.* ♂ (Bavarian Oberpfalz).

The following were recorded by the observers, and for the localities stated.—

Alfken (Bremen), the bee Halictus tomentosus *Schenck* ♀. MacLeod (Pyrenees), the humble-bee Bombus terrester *L.* ☿ (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 333). Schletterer (Pola), 6 bees—1. Andrena carbonaria *L.*; 2. Bombus argillaceus *Scop.*; 3. B. terrester *L.*; 4. Eucera alternans *Brull.*; 5. Halictus sexcinctus *F.*; 6. Megachile sericans *Fonsc.*

2356. M. candidissimum L.—

Visitors.—Schletterer observed the following 16 bees at Pola.—

1. Anthidium diadema *Ltr.*; 2. A. septemdentatum *Ltr.*; 3. Andrena carbonaria *L.*; 4. Bombus argillaceus *Scop.*; 5. B. terrester *L.*; 6. Coelioxys aurolimbata *Först.*; 7. Eucera hispana *Lep.*; 8. Halictus patellatus *Mor.*; 9. H. quadricinctus *F.*; 10. H. sexcinctus *F.*; 11. Megachile lefeburei *Lep.*; 12. M. maritima *K.*; 13. M. muraria *Retz.*; 14. M. sericans *Fonsc.*; 15. Osmia fulviventris *Pz.*; 16. Xylocopa violacea *L.*

2357. M. anisodon C. Koch. (=M. vulgare *L.*, according to the *Index Kewensis*).—

Visitors.—Loew observed the humble-bee Bombus terrester *L.* ♂, skg., in the Berlin Botanic Garden.

2358. M. propinquum Fisch. et Mey.—

Visitors.—The following were recorded by the observers, and for the localities stated.—

Loew (Berlin Botanic Garden), 2 bees, skg.—Apis mellifica *L.* ☿, and Anthidium manicatum *L.* ♀. Mocsary (Hungary, teste Friese), the rare bee Coelioxys polycentris *Först.*

2359. M. peregrinum L. (=M. creticum *Mill.*) (Schulz, 'Beiträge,' I, p. 85.)—The flowers of this species are feebly protandrous. The corolla is 5–5½ mm. long, and its tube is lined with hairs from the entrance to within about 2 mm. from the base.

The anthers lie immediately behind the opening of the flower, almost filling it, so that the inserted proboscis of an insect must always brush them. The style does not elongate and unfold its two branches until dehiscence is almost at an end, but continues to grow even when the flower begins to fade, sometimes reaching a length of 4 mm. As the stigma grows through the anthers, automatic self-pollination usually takes place.

729. Physostegia Benth.

Protandrous, with opposite movement of the stamens and style. (Delpino, 'Ult. oss.,' p. 148.)

2360. P. virginiana Benth. (Delpino, loc. cit.)—The external anther-valves possess marginal teeth, which assist visitors to empty the pollen completely.

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Hymenoptera. *Apidae*: 1. Bombus agrorum *F.* ♂, trying to suck; 2. Halictus cylindricus *F.* ♀, creeping far into the flowers; 3. Prosopis communis *Nyl.* ♀, creeping into the flowers. **B. Lepidoptera.** *Rhopalocera*: 4. Pieris brassicae *L.*, skg.

730. Ballota L.

Protandrous bee flowers with nectar secreted and concealed in the usual way. Often gynomonoecism, more rarely gynodioecism.

2361. B. nigra L. (Sprengel, 'Entd. Geh.,' p. 309; Herm. Müller, 'Fertilisation,' pp. 498–9, 'Weit. Beob.,' III, p. 46; Schulz, 'Beiträge,' I, p. 85; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 364; Kirchner, 'Flora v. Stuttgart,' p. 631; Loew,

'Blütenbiol. Floristik,' pp. 391, 394, 399; Knuth, 'Blütenbiol. Herbstbeob.,' 'Blütenbiol. Beob. a. d. Ins. Rügen.')—The dirty-red flowers of this species possess a nectar-guide on the lower lip in the form of white lines pointing towards the corolla-tube. As in most labiate flowers, the lower lip forms a convenient alighting-platform, and its lateral lobes act as holdfasts for their fore- and middle-legs: a longitudinal furrow on the lower lip serves as a guide to the proboscis. The nectar, secreted by the base of the ovary, is concealed at the bottom of the corolla-tube, which is 7 mm. long, and slightly widened at the top. It is accessible to a proboscis 6 mm. long, as the widening of the entrance permits the insertion of a bee's head to a depth of one mm. A circlet of stiff hairs situated above the nectar is described by Sprengel as a nectar-cover. This is, however, unnecessary, owing to the horizontal position of the flower and the arching of the upper lip. Hermann Müller considers the circlet as a protection against useless nectar-seeking flies, as it prevents their broad proboscides from entering, though it is no obstacle to those of bees.

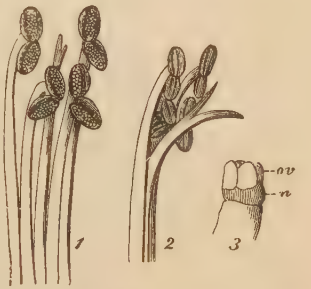


FIG. 338. *Ballota nigra*, *L.* (after Herm. Müller). (1) Reproductive organs of a young flower, seen obliquely from the front (× 7). (2) Do. of an older flower. (3) Ovary (*ov*) and nectary (*n*).

At the beginning of anthesis the stigmatic branches, still almost apposed, are situated behind the anthers. When these have dehisced, the style bends downwards, the papillose stigmatic branches diverging at the same time, so that they are first brushed against by a bee visitor. If the pollen is not removed by insects, a large part of it clings to the hairy margins of the upper lip, and the whole length (including the papillae) of the lower stigmatic branch, which bends down between the hairs, is dusted with the retained pollen, so that automatic self-pollination is effected.

Schulz says that besides hermaphrodite flowers, gynomonoeciously distributed female ones also occur (often up to 15 %). Gynodioecism is rare.

VISITORS.—Loew observed the following bees.—Mecklenburg (M.) and Brandenburg (B.) ('Beiträge,' p. 43).—

1. Anthidium manicatum *L.* ♀ and ♂, skg., ♀ also po-cltg. (M.); 2. Anthophora furcata *Pz.* ♂, skg. (M.); 3. A. quadrimaculata *F.* ♀, do. (B.); 4. Bombus agrorum *F.* ♂, do. (B.); 5. B. sylvarum *L.* ♂ (B.); 6. Tetralonia salicariae *Lep.* ♂, do. (B.): Silesia (op. cit., p. 34), Saropoda rotundata *Pz.* ♂, skg.

Schenck saw the following 8 bees in Nassau.—

1. Anthidium manicatum *L.*; 2. Biastes emarginatus *Schenck*; 3. Bombus agrorum *F.*; 4. Epeoloides caecutiens *F.*; 5. Halictus clypearis *Schenck*, ♀ freq., ♂ once; 6. Podalirius furcatus *Pz.*; 7. P. retusus *L.*; 8. P. vulpinus *Pz.*

Burkill and Willis observed the following at Cambridge ('Fls. and Insects in Gt. Britain,' Part 1).—

A. Diptera. *Syrphidae*: 1. Rhingia rostrata *L.*, skg; 2. Syritta pipiens *L.*, do.; 3. Syrphus sp., do. **B. Hymenoptera.** *Apidae*: all skg.: 4. Bombus agrorum *F.*; 5. B. cognatus *Steph.*; 6. B. latreillellus *Kirby*; 7. Halictus sp. **C. Lepidoptera.** (*a*) *Noctuidae*: 8. Plusia gamma *L.*, skg. (*b*) *Rhopalocera*: 9. Pieris rapae *L.*, skg.

Herm. Müller (H. M.) and Buddeberg (Budd.) give the following list.—

A. Diptera. (*a*) *Bombyliidae*: 1. Bombylius sp., skg. (Budd.). (*b*) *Syrphidae*: 2. Rhingia rostrata *L.*, skg. (Budd.). **B. Hymenoptera.** *Apidae*: 3. Anthidium manicatum *L.* ♀ skg. and po-cltg., ♂ skg. (H. M., Budd.); 4. A. punctatum *Ltr.* ♂, skg. (Budd.); 5. Anthophora furcata *Pz.* ♀ and ♂, skg. and po-cltg. (H. M., Budd.); 6. A. quadrimaculata *Pz.* ♀ and ♂, very common, skg. and po-cltg. (H. M., Budd.); 7. Apis mellifica *L.* ☿, skg. (H. M.); 8. Bombus agrorum *F.* ♀, do. (H. M.); 9. B. hypnorum *L.* ☿, do. (H. M.); 10. B. lapidarius *L.* ☿, do. (H. M.); 11. B. rajellus *K.* ♀, skg. and po-cltg. (H. M.); 12. B. muscorum *F.* ☿, skg. (Budd.); 13. B. sylvarum *L.* ☿, do. (H. M., Budd.); 14. B. tristis *Seidl.* ☿, do. (Budd.); 15. Crocisa scutellaris *F.* ♀, do. (Budd.); 16. Megachile argentata *F.* ♀, do. (Budd.); 17. M. fasciata *Sm.* ♀ and ♂, do. (H. M., Budd.); 18. M. lagopoda *K.* ♂, do. (H. M., Bavarian Oberpfalz); 19. Osmia adunca *Pz.* ♀ and ♂, do. (Budd.); 20. O. aenea *L.* ♀, do. (H. M., Budd.); 21. O. aurulenta *Pz.* ♀, do. (H. M., Budd.); 22. O. fulviventris *Pz.* ♀, do. (H. M., Thuringia); 23. Psithyrus rupestris *F.* ♀, do. (H. M.); 24. Rhophites quinquespinosus *Spin.* ♂, in large numbers, do. (Budd.); 25. Saropoda bimaculata *Pz.* ♀ and ♂, freq., do. (Budd.). **C. Lepidoptera.** (*a*) *Rhopalocera*: 26. Argynnis paphia *L.*, skg. and pollinating (H. M.); 27. Colias hyale *L.*, do. (H. M.); 28. Pieris brassicae *L.*, do. (H. M.); 29. P. rapae *L.*, do. (H. M.); 30. Vanessa cardui *L.*, do. (H. M.); 31. V. urticae *L.*, do. (H. M.). (*b*) *Sphingidae*: 32. Macroglossa stellatarum *L.*, skg. and pollinating (H. M.).

The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel), the honey-bee, skg., 3 skg. humble-bees (1. Bombus lapidarius *L.*; 2. B. pratorum *L.*; 3. B. terrester *L.*), and 2 skg. butterflies (Vanessa io *L.*, and Pieris sp.): ('Greifswalder Oie,' Rügen), 2 long-tongued bees (Podalirius (Anthophora) aestivalis *Pz.* ♀, and B. vulpinus *Pz.* ♀) (=Anthophora quadrimaculata *Pz.*), both freq.

Wüstnei (Alsen), 2 bees—Anthophora quadrimaculata *F.*, and Anthidium manicatum *L.* Alfken (Bremen), 2 bees—Bombus agrorum *F.* ♂, skg., and Podalirius vulpinus *Pz.* ♀, do. Krieger (Leipzig), 3 bees—1. Anthidium manicatum *L.*; 2. Podalirius vulpinus *Pz.*; 3. Rophites quinquespinosus *Spin.* Friese (Saalthal), 6 bees—1. Anthidium manicatum *Gir.*; 2. Bombus hortorum *L.* ♂; 3. B. hypnorum *L.* ☿; 4. B. lucorum *L.*; 5. B. subterraneus *L.*, var. borealis *Schmiedekn.*; 6. Rophites quinquespinosus *Spin.* Gerstäcker (Kreuth and Bavarian Alps), the humble-bee Bombus mendax *Gerst.* ☿, in large numbers. Schletterer, for Istria (I.) and the Tyrol (T.), 3 bees—1. Anthidium septemdentatum *Ltr.* (I.); 2. Bombus mastrucatus *Gerst.* (T.); 3. B. mendax *Gerst.* ♀ and ♂, very rare (T.). von Dalla Torre (Tyrol) and Hoffer (Steiermark), the humble-bee Bombus mastrucatus *Gerst.* ♂. Ducke (Aquileia, and Austrian Silesia), 3 bees—1. Podalirius pubescens *F.* ♀ and ♂; 2. P. quadrifasciatus *Vill.* ♀ and ♂; 3. Rophites quinquespinosus *Spin.* ♀ and ♂. Loew, for Brunswick (B.) and Steiermark (S.) ('Beiträge,' p. 52), 3 bees—1. Anthophora furcata *Pz.* ♀, skg. (B.); 2. Bombus rajellus *K.* ♂, skg. (S.); 3. Halictus albipes *F.* ♀, po-cltg. (S.): (Tyrol), the humble-bee Bombus pascuorum *Scop.* ♂, skg. (op. cit., p. 61). Friese (Germany), the bee Anthidium manicatum *L.*: (Baden, Alsace, Thuringia, and Switzerland), the bee Rophites quinquespinosus *Spin.*, not freq.: (Nassau, *teste* Schenck), the bee Biastes emarginatus *Schenck*: (Berlin Botanic Garden), 3 bees—1. Anthidium manicatum *L.*, ♀ skg., ♂ swarming round the flowers in search of the ♀; 2. Bombus agrorum *F.* ♂, skg.; 3. Osmia rufa *L.* ♀, do.

Also on the var. (*b*) *foetida* Luck., the following.—

MacLeod (Belgium), a humble-bee (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 375): (Pyrenees), 4 humble-bees, 2 sp. of Anthophora, a Lepidopterid, and a hover-fly (op. cit., iii, 1891, p. 333). H. de Vries (Netherlands), the humble-bee Bombus agrorum *F.* ♂.

731. Leonurus L.

Protandrous to homogamous bee flowers; with nectar secreted and concealed as usual.

2362. L. Cardiaca L. (Sprengel, 'Entd. Geh.,' p. 310; Herm. Müller, 'Weit. Beob.,' III, p. 48, 'Alpenblumen,' p. 312; Knuth, 'Bloemenbiol. Bijdragen'; Loew, 'Blütenbiol. Floristik,' p. 391; Kirchner, 'Flora v. Stuttgart,' p. 632.)—The pale-red corolla of this species bears nectar-guides on the lower lip, the filaments, and the mouth of the upper lip, in the form of dark-purple spots. The two anterior stamens bend sideways after dehiscence. The corolla-tube is only 4 mm. long. Warnstorf describes the pollen-grains as white in colour, ellipsoidal, delicately tuberculate, about 35 μ long and 15–18 μ broad.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Sprengel, humble-bees. Knuth, the humble-bee Bombus lapidarius ♀ and ♂, skg. Loew (Brandenburg), the bee Coelioxys rufescens *Lep.* ♂, skg. ('Beiträge,' p. 44): (Berlin Botanic Garden), on the var. *villosa* the humble-bee Bombus agrorum *F.* ♂, skg. Herm. Müller (Bavarian Oberpfalz), the honey-bee and 3 humble-bees—1. Bombus agrorum *F.* ☿; 2. B. pratorum *L.* ☿; 3. B. tristis Seidl. ☿, all skg.: (Alps), the humble-bee Bombus lapidarius *L.* ☿, skg.

2363. L. Marrubiastrum L. (=Chaiturus Marrubiastrum *Spenn.*). (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—Warnstorf says that in this autogamous species the yellow anthers are borne on short filaments and enclosed in the corolla. They are beset with viscid spherules. The slightly curved corolla-tube is 5 mm. long. The pollen-grains are white in colour, irregularly tetrahedral, feebly tuberculate, on an average 37 μ in diameter.

Visitors.—Knuth observed the following bees, all skg., in the Kiel Botanic Garden.—

1. Apis mellifica *L.* ☿; 2. Bombus hortorum *L.* ♀ (a variety); 3. B. pratorum *L.*; 4. B. lapidarius *L.*, one ☿ (between 8 and 9 a.m., 30. 8.'98) visiting successive verticillasters, and going steadily from plant to plant, in spite of sharp showers of rain and a strong wind.

Gerstäcker (Berlin) saw the bee Coelioxys aurolimbata *Foerst.*

2364. L. lanatus Pers.—

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Coleoptera. *Coccinellidae*: 1. Coccinella bipunctata *L.*, resting outside the entrance of the flower. **B. Hymenoptera.** *Apidae*: all skg.: 2. Anthidium manicatum *L.* ♀; 3. Apis mellifica *L.* ☿; 4. Bombus agrorum *F.* ☿ and ♂; 5. B. terrester *L.* ♀; 6. Psithyrus rupestris *F.* ♂.

732. Scutellaria Riv.

Homogamous to protandrous bee flowers, apparently possessing a Lepidopterid door. Nectar secreted and concealed as usual.

2365. S. galericulata L. (Sprengel, 'Entd. Geh.,' p. 312; Herm. Müller, 'Fertilisation,' p. 486; Kirchner, 'Neue Beob.,' p. 58; Schulz, 'Beiträge,' II, pp. 196, 222; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; MacLeod, Bot. Centralbl., Cassel, xxix, 1887, Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 375–516.)—In this species the lower lip of the blue-violet corolla is wide and shallow, and bears a nectar-

guide in the form of a white patch traversed by three dark-violet lines, the middle one being continued into the corolla-tube. The upper lip is trifid, with two deep, lateral folds, forming a laterally compressed, upright, middle section, enclosing anthers and stigma, and into which a narrow entrance leads. The two lateral lobes of the upper lip are situated close above the lower lip, forming a second entrance to the flower. One of these openings is above and one below the tips of the lateral lobes of the upper lip. Kirchner says that the upper one probably serves as a Lepidopterid door. A bee forces its head and the fore-part of its body into the flower, separating the folds of the upper lip to open so far that its body can enter. The anthers and the simultaneously matured stigma are thus drawn down upon it. The two pairs of anthers are situated one behind the other in the galeate part of the upper lip; the downwardly bent end of the style with the stigma lies in front of the anthers of the two shorter stamens, automatic self-pollination being thus inevitable. When visited by insects there are equal chances of self- and of cross-pollination. Warnstorf says that the longer stamens possess one anther-lobe, and the shorter ones two. The anthers of the longer stamens point downwards and dehisce in that direction, those of the shorter ones dehiscing upwards and downwards. Only the lower stigmatic branch is developed, and this is situated between the anterior and posterior anthers, so that self-pollination is rendered very difficult. The flowers are frequently perforated. The pollen-grains are white in colour, ellipsoidal, delicately tuberculate, up to 31 μ in length and 18–21 μ in breadth.

FIG. 339. *Scutellaria galericulata*, *L.* (from nature). *A*. Corolla, seen from the side (enlarged). *B*. Do., seen from the front. *ft*, Lepidopterid door; *ht*, humble-bee door.

Schulz describes the hermaphrodite flowers as protandrous. Besides these he observed gynomonoeciously and gynodioeciously distributed female ones (up to 5 % at Halle). He also noticed perforation by Bombus terrester *L.*

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller, the butterfly Rhodocera rhamni *L.* MacLeod (Flanders), a hover-fly, po-dvg. (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 372.) Loew (Berlin Botanic Garden), 2 bees, skg.—Anthidium manicatum *L.* ♀, and Bombus terrester *L.* ♂.

2366. S. minor Huds. (MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 377.)—The violet flowers of this species are smaller than those of S. galericulata, and their entire mechanism less complete. MacLeod states that the entrance of the flower stands wide open, so that the stigma and anthers are not covered in front. The elasticity of the upper lip, feeble in S. galericulata, is here almost absent. The corolla-tube being shorter than in that species, the nectar is accessible to short-tongued insects.

2367. S. hastifolia L. (Schulz, 'Beiträge,' II, pp. 196, 222.)—Schulz describes this species as gynodioecious with protandrous hermaphrodite flowers at Leipzig. He observed occasional perforation by humble-bees.

VISITORS.—Loew (Berlin Botanic Garden) observed the long-tongued humble-bee Anthidium manicatum *L.* ♀, skg.

2368. S. alpina L. (MacLeod, 'Pyreneënbl.,' pp. 58–61.)—The flower mechanism of this species agrees essentially with that of S. galericulata. Here again the upper lip can be bent back on a hinge-joint. When the pressure of the insect visitor is removed, the lip resumes its original position and encloses stigma and anthers. The narrow upper opening of the tip of the upper lip again forms a Lepidopterid door. A humble-bee can insert its head 5–6 mm. deep in the upper and widened part of the corolla-tube, and it is then only 10–12 mm. from the nectar-bearing base of the flower. The nectary is situated on the front side of the base of the ovary.

The flowers are blue-violet in the Alps, and the orange-coloured nectar-guide on the swelling of the lower lip is larger than that of the darker flowers in the Pyrenees.

Visitors.—MacLeod observed a humble-bee, apparently Bombus hortorum *L.* ☿.

2369. S. peregrina L.—

Visitors.—Loew (Berlin Botanic Garden) observed the humble-bee Bombus hortorum *L.* ☿, its head thickly covered with pollen.

2370. S. albida L.—

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

Hymenoptera. (*a*) *Apidae*: all skg.: 1. Bombus cognatus *Steph.* ♀; 2. B. terrester *L.* ♀; 3. Osmia aenea *L.* ♀. (*b*) *Tenthredinidae*: 4. Athalia rosae *L.*, settling on the outside of the flowers.

2371. S. altissima L.—

Visitors.—Loew (Berlin Botanic Garden) observed the bee Chelostoma nigricorne *Nyl.* ♀, creeping right into the flowers and skg.

733. Prunella L.

Protandrous or homogamous bee flowers; with nectar secreted and concealed as usual. Sometimes gynomonoecism or gynodioecism.

2372. P. vulgaris L. (Sprengel, 'Entd. Geh.,' p. 312; Herm. Müller, 'Fertilisation,' pp. 489–91, 'Alpenblumen,' p. 315, 'Weit. Beob.,' III, pp. 51–2; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; MacLeod, Bot. Centralbl., Cassel, xxix, 1887, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 377–8; Kirchner, 'Neue Beob.,' p. 58, 'Flora v. Stuttgart,' p. 635; Knuth, 'Blütenbiol. Beob. a. d. nordfr. Ins.,' pp. 118, 166, 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 239; Ogle, Pop. Sci. Rev., London, ix, 1870; Schulz, 'Beiträge,' I, p. 85; Loew, 'Blütenbiol. Floristik,' p. 394.)—The flowers of this species are violet in colour. The corolla-tube of the large-flowered hermaphrodites is 7–8 mm. long. The anthers are situated in two rows, one behind the other, below the upper lip. The longer filaments possess a sharp tooth below the anthers, directed outwards, its free end resting against the arched surface of the upper lip. Ogle and Hermann Müller consider that this is an arrangement for keeping the downwardly dehiscing anthers at the side of the median stigmatic branches, a position in which they are most exposed to contact with visitors. Each of the shorter filaments possesses a similar tooth, serving the same purpose, but much less developed. The flowers are partly homogamous, and partly, according to Schulz, feebly or strongly protandrous. The back of a humble-bee first touches the papillae of the projecting lower stigmatic branch, and then becomes dusted with pollen.

Cross-pollination is thus effected by insect-visits. (Hermann Müller did not observe automatic self-pollination; Axell, however, says that it does occur and is effective.)

In addition to hermaphrodite flowers, there are often female ones, according to Schulz, up to 50 %, generally 10–20 %, and these are distributed partly gynomonoeciously and partly gynodioeciously. Kirchner describes two forms of small-flowered female stocks. In one case the corolla is of the normal form; the stamens in the usual position, but with white indehiscent anthers, and the style of the same length as the upper lip. The other kind of female flower possesses stamens still further reduced; the lower lip is directed so far upwards that the entrance of the corolla is only one mm. high; and the stigma projects far beyond the upper lip.

Besides large hermaphrodite flowers, MacLeod observed smaller ones (at Ghent), which seemed to be almost cleistogamous and were self-fertilized. There were many intermediate stages between the two types. Purely female flowers were not observed.

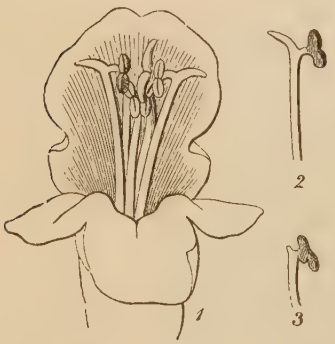


FIG. 340. *Prunella vulgaris*, *L.* (after Herm. Müller). (1) Hermaphrodite flower, seen from the front. (2) Upper part of a longer stamen. (3) Do. of a shorter stamen.

Warnstorf describes three forms for Neu-Ruppin.—

(1) Large flowers: corolla 15–16 mm. long from the base of the tube to the tip of the upper lip, entrance wide; corolla-tube longer than the calyx; lower lip strongly and irregularly dentate; hermaphrodite; style generally of the same length as the longer stamens; autogamy effected by the rolling up of the stigmatic branches; pollen-grains white in colour, ellipsoidal, tuberculate, about 50–56 μ long and 37–43 μ broad.

(2) Medium-sized flowers: corolla 10–12 mm. long, entrance wide; style sometimes of the same length as the longer stamens, sometimes a little shorter; sometimes hermaphrodite, with anthers partly reduced or entirely aborted.

(3) Small flowers: corolla only 8 mm. long; lower lip curved inwards and upper lip depressed, making the entrance of the flower very narrow; style generally shorter than the longer stamens; hermaphrodite, or female by reduction of anthers.

Stocks bearing large and medium-sized flowers predominate at Ruppin; the small-flowered form seems to prefer the turf in gardens and parks. The keeled, lateral teeth of the upper lip do not always grasp the lower, as described in Floras, but often merely touch it. The order of development of the flowers is remarkable. Of two neighbouring three-flowered half-whorls, the middle one of the upper and the lateral ones of the lower open simultaneously, so that there are always three open flowers near each other. (Warnstorf.)

VISITORS.—Knuth observed the following bees.—

North Frisian Is., the honey-bee, and 3 humble-bees, skg.—1. Bombus rajellus *K.*; 2. B. lapidarius *L.*; 3. B. terrester *L.*, skg. Helgoland, the humble-bee Bombus agrorum *F.* ☿, skg. Thuringia, the short-tongued bee Halictus punctulatus *K.* ♀, and 4 long-tongued humble-bees—1. Bombus agrorum *F.* ☿; 2. B. hortorum *L.*, var. hortorum *L.*; 3. B. soroënsis *F.*, var. proteus *Gerst.* ☿; 4. B. terrester *L.* ♀ and ☿.

Höppner saw the following 13 bees at Bremen.—

1. Anthidium strigatum *Pz.* ♀; 2. Andrena convexiuscula *K.* ♀; 3. Bombus arenicola *Thoms.* ♀; 4. B. hortorum *L.* ♀; 5. B. jonellus *K.* ☿; 6. B. sylvarum *L.* ♀, ☿, and ♂; 7. B. terrester *L.* ♀; 8. B. variabilis *L.* ♀ and ♂; 9. Megachile circumcincta *K.* ♀; 10. M. willughbiella *K.* ♀; 11. Podalirius borealis *Mor.* ♀ and ♂; 12. P. furcatus *Pz.* ♀ and ♂; 13. P. retusus ♀ and ♂.

Herm. Müller gives the following list for Central and South Germany.—

A. Hymenoptera. *Apidae*: 1. Anthophora furcata *Pz.* ♂, skg. legitimately; 2. Apis mellifica *L.* ☿, skg.; 3. Bombus lapidarius *L.* ♀, ☿, and ♂, do.; 4. B. pratorum *L.* ☿, do.; 5. B. sylvarum *L.* ☿, do.; 6. B. terrester *L.* ☿, do.; 7. Cilissa haemorrhoidalis *Pz.* ♂, vainly trying to suck the large flowers, and getting its upper side dusted with pollen, so as to cross any small flowers subsequently visited; 8. Halictus morio *F.* ♀, po-cltg.; 9. H. leucopus *K.* ♀, do. (Bavarian Oberpfalz); 10. Megachile willughbiella *K.* ♂, skg. legitimately. **B. Lepidoptera.** *Rhopalocera*: 11. Hesperia sylvanus *Esp.*, skg., and occasionally effecting pollination; 12. Lycaena argiolus *L.*, do.; 13. L. icarus *Rott.*, skg.; 14. Melithaea athalia *Esp.*, as 11; 15. Pieris napi *L.*, skg. (Thuringia).

The following were recorded by the observers, and for the localities stated.—

Warnstorf, humble-bees of undetermined sp. Alfken (Bremen), the bee Psithyrus campestris *Pz.* ♀, skg. Loew (Riesengebirge), the butterfly Pieris brassicae *L.*, skg. ('Beiträge,' p. 52): (Silesia), 2 butterflies—Pieris brassicae *L.*, skg., and Polyommatus alciphron *Rott.* (op. cit., p. 34). Schletterer (Tyrol), 4 bees—1. Bombus confusus *Schenck*; 2. B. muscorum *F.*; 3. B. soroënsis *F.*; 4. Megachile ericetorum *Lep.* (also by von Dalla Torre, Tyrol). H. de Vries (Netherlands), 4 humble bees—1. Bombus agrorum *F.* ♀ and ♂; 2. B. sylvarum *L.* ♂; 3. B. subterraneus *L.* ☿ and ♂; 4. B. terrester *L.* ☿ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875). MacLeod (Flanders), the honey-bee, 4 humble-bees, one Halictus, a hover-fly, and 5 Lepidoptera (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 378): (Pyrenees), 7 humble-bees, a Bombyliid, and a hover-fly (op. cit., iii, 1891, p. 337). Willis (south coast of Scotland), 2 humble-bees, freq., skg. (Bombus agrorum *F.*, and B. terrester *L.*), and a butterfly (Pieris napi *L.*, skg.) ('Fls. and Insects in Gt. Britain,' Part I). Scott-Elliot (Dumfriesshire), 2 humble-bees ('Flora of Dumfriesshire,' p. 137). Schneider (on plants introduced into Arctic Norway), the humble-bee Bombus agrorum *F.* (Tromsø Mus. Aarsheft., 1894). Herm. Müller (Alps), a hover-fly, 5 humble-bees, and 10 Lepidoptera. Schulz, flowers perforated by humble-bees.

2373. P. grandiflora Jacq. (Herm. Müller, 'Alpenblumen,' pp. 312–14, 'Weit. Beob.,' III, p. 52; Schulz, 'Beiträge,' I, p. 86; Kirchner, 'Flora v. Stuttgart,' p. 634.)—This species is gynomonoecious or gynodioecious, with protandrous (and, according to Schulz, also occasionally homogamous) hermaphrodite flowers. The lower part of the corolla-tube is directed obliquely upwards. Above the circlet of hairs serving as a nectar-cover it widens considerably, turning almost vertically upwards. The distance between the entrance of the flower and the circlet of hairs is 9–10 mm. This upper part of the tube is so wide that a humble-bee's head can enter easily. The lower lip is cup-shaped; the upper shelters the anthers and style during the first (male) stage of anthesis. The anthers are not arranged as usual in two rows one behind the other, but all four are in one row. When a bee probes for nectar, the two outer ones are turned downwards by means of a lever mechanism, so that pollen is deposited on the insect's back. The two inner anthers are immovable, and only touched by larger humble-bees. In the second (female) stage, the style with the stigma projects so far from the upper lip, and in older flowers bends so far down-

wards, that it touches even the backs of smaller visitors which are usually sprinkled with pollen by means of the lower appendages. Automatic self-pollination is excluded.

The female flowers are smaller (the style projects from the corolla); the anthers are white and sterile. They are (up to 20 %) gynomonoecious or gynodioecious.

The flowers are frequently perforated by Bombus masticatus Gerst. and B. terrester L.

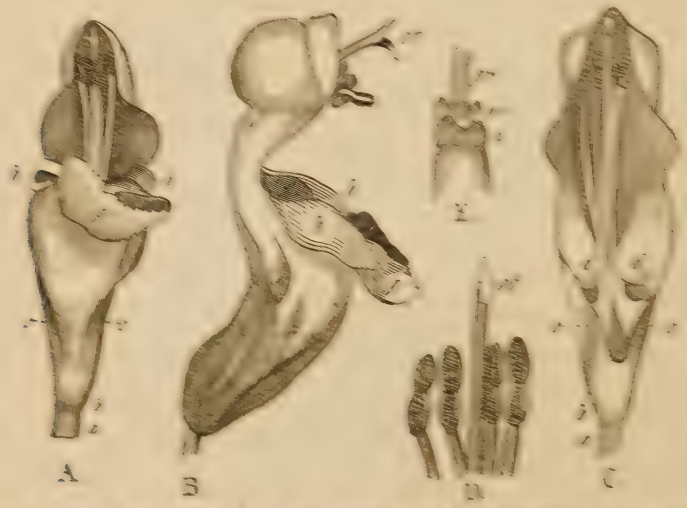


FIG. 30.—*Prunella grandiflora* (after from Herm. Müller's 'Alpenblumen'). A. Flower in the first male stage, seen directly from the front after removal of the calyx. B. Do. in the second male stage, seen from the side. C. Do., after removal of the calyx and the front part of the corolla. *a* to *d*, Anthers and stigma of C. D. Nectary, ovary and style in C. *a*, narrow base of corolla-tube; *b*, commencement of wider part of do.; *c* and *d*, ventral lobe and sacculations of do.; *e*, side of upper lip; *f*, anthers in lower; *g* and *h*, central and lateral lobes of lower lip; *i*, ovary; *k*, style; *l*, stigma.

VISITORS.—The following were recorded by the observers, and for the localities named:—

Herm. Müller (Alps), 4 humble-bees and 2 Lepidoptera. Schletterer and von Dalla Torre (Tyrol), 2 humble-bees.—Bombus hypnorum *L.* ♀ and *B. pratorum L.* ♀ MacLeod (Pyrenees), 2 humble-bees and a Lepidopteron (Soc. Journ. Dodonaea, Ghent, iii. 1891, p. 337). Loew (Berlin Botanic Garden), the pollen-fly Platycheirus peltatus *Meig.*

2874. P. laciniata L. (=*P. alba Pall.*).—Schulz says that this species is gynodioecious (at Bonn up to 5 %) with protandrous hermaphrodite flowers. Occasional perforations by humble-bees were observed.

VISITORS.—MacLeod (Pyrenees) observed 2 humble-bees (Soc. Journ. Dodonaea, Ghent, iii. 1891, p. 337).

2875. P. hyssopifolia L.—

VISITORS.—Loew (Berlin Botanic Garden) observed the bee Anthidium manicatum *L.* ♂ sing.

LITERATURE.—Delpino, 'Ult. oss.' p. 130; Hildebrand, Bot. Ztg., Leipzig xxviii. 1870.

734. Prostanthera Labill.

In species of this genus the connective possesses long appendages; visitors strike against these and are sprinkled with pollen in doing so.

735. Ajuga L.

Generally homogamous, rarely protandrous or protogynous humble-bee flowers with a very short upper lip, the lower ones and the bracts serving as an imperfect protection for the inside of the androecium. Corolla-tube with a circlet of hairs; nectar secreted and concealed as usual. Occasional gynomonoecism.

2376. A. reptans L. (Sprengel, 'Entd. Geh.,' pp. 299–300; Herm. Müller, 'Befruchtung,' pp. 301–2, 'Weit. Beob.' III, pp. 45–6, 'Alpenblumen,' p. 369; Kirchner, 'Neue Beob.,' p. 59; Schulz, 'Beiträge,' I, p. 27, II, pp. 136–9, 222; Macleod, Bot. Jaarb. Dodonaea, Gent, III, 1891, p. 337, V, 1893, pp. 378–9, Bot. Centralbl., Cassel, xxx., 1887; Loew, 'Blütenbiol. Florist.' p. 391; Knuth, 'Blumen- und Insekten.')—The lower lip of the blue, rarely pink or white flowers of this species is marked with brighter lines that serve as nectar-guides. They are generally homogamous, but sometimes protandrous or protogynous. The corolla-tube is 9 mm. long, the lowest 2½ mm. being ventricose. The nectar, which is secreted by a thick yellow fleshy gland situated on the front of the ovary, is stored in the enlargement of the tube. As the upper lip is almost entirely absent, the anthers and stigma are exserted; they are protected from rain by the bracts of the flowers situated above.

The stigmatic branches usually diverge as far in flowers just opening as in older ones, the lower branch resting on the anthers (which lie very close together) of the shorter stamens. It is therefore not touched at first by the smaller insect visitors, which do not press the stamens apart very forcibly though they are nevertheless sprinkled by the pollen-covered surfaces that are directed downwards and forwards. The stamens separate later on, and the style drops down between them, so that the lower stigmatic branch with its papillose surface is brought into the entrance, and touched by visitors before the anthers. The length of the style varies, however, so that the stigma is not always situated above the anthers, but sometimes behind or in front of them. In some cases, therefore, cross-pollination is effected more easily, in others self-pollination.

The course of maturation of the stigma and anthers also varies: sometimes they mature simultaneously, sometimes one before the other: homogamy is, however, much more frequent than protogyny, and this is commoner than protandry.

Should insect-visits fail automatic self-pollination often takes place, the papillose tip of the stigma sliding down through the pollen clinging thickly to the lower side of the anthers; autogamy is, however, less effective than allogamy. Perforation by humble-bees is not infrequent.

MacLeod observed a second kind of flower at Ghent besides the ordinary ones. This form is large, markedly protandrous, and more brightly coloured. The corolla-tube is 11–12 mm. long, and the lower lip 8–9 mm. broad. In the second (female) stage the stamens lean backwards, while the style bends so far forwards that the stigma occupies the entrance of the flower.

Visitors.—Alfken and Höppner (H.) observed the following 14 bees at Bremen.—

Apidae: 1. Bombus agrorum *F.* ♀, very common, skg.; 2. B. arenicola *Thoms.* ♀ (H.); 3. B. derhamellus *K.* ♀, freq., skg.; 4. B. distinguendus *Mor.* ♀, rare, skg.; 5. B. hortorum *L.* ♀, skg.; 6. B. jonellus *K.* ♀ and ☿ (H.); 7. B. muscorum *F.* ♀ (H.); 8. B. sylvarum *L.* ♀ (H.); 9. Melecta luctosa *Scop.* ♀ and ♂, skg. (H.); 10. Nomada alboguttata *H. Sch.* ♀ (H.); 11. N. ochrostoma *K.* ♀ (H.); 12. Podalirius acervorum *L.* ♀, freq., skg.; 13. P. retusus *L.* ♀ and ♂, skg. (H.); 14. Psithyrus barbutellus *K.* ♀, skg.

Friese saw the following bees in Alsace (A.), Baden (B.), Fiume (F.), Hungary (H.), Mecklenburg (M.), and Trieste (T.).—

1. Melecta armata *Pz.*; 2. Osmia aurulenta *P.* (M.), rare; 3. O. emarginata *Lep.* (F., T., H.); 4. Podalirius acervorum *L.*, freq. (B., A.); 5. B. parietinus *F.* (M.); 6. P. retusus *L.*, occasional (B., A.), not infreq. (M.); 7. Stelis nasuta *Ltr.* (H.); 8. Xylocopa violacea *L.* ♀ and ♂ (A.).

Herm. Müller gives the following list.—

A. Diptera. (*a*) *Bombyliidae*: 1. Bombylius sp., skg. (Budd., Nassau). (*b*) *Syrphidae*: 2. Eristalis tenax *L.*, po-dvg. (Thuringia); 3. Rhingia rostrata *L.*, skg. and po-dvg., covering its head with pollen; 4. Syrphus balteatus *Deg.*, po-dvg. (Thuringia). **B. Hymenoptera.** *Apidae*: 5. Andrena labialis *K.* ♂, failing (?) to reach the nectar; 6. A. nitida *Fourcr.* ♀, do.; 7. Anthophora aestivalis *Pz.* ♂ skg., ♀ skg. and po-dvg. (Thuringia); 8. A. pilipes *F.* ♀ and ♂, skg. legitimately, and dusting its head with pollen; 9. Apis mellifica *L.* ☿, thrusting most of its head into the corolla-tube; 10. Bombus agrorum *F.* ♀, skg., and dusting its head with pollen; 11. B. confusus *Schenck* ♀, do.; 12. B. hortorum *L.* ♀ and ☿, skg. and po-cltg.; 13. B. lapidarius *L.* ♀, skg. (also in the Alps); 14. B. pratorum *L.* ♀ skg. and po-cltg., ☿ skg., and dusting its head with pollen; 15. B. sylvarum *L.* ♀, do.; 16. B. terrester *L.* ♀, skg. legitimately; 17. Crocisa scutellaris *F.* ♀ and ♂, skg. (Thuringia); 18. Eucera longicornis *L.* ♂ skg., ♀ skg. and po-cltg. (Thuringia); 19. Halictus zonulus *Sm.* ♀, apparently not reaching the nectar; 20. Osmia aenea *L.* ♀, skg. legitimately, and dusting its head with pollen; 21. O. aurulenta *Pz.* ♀ and ♂, skg. (Thuringia); 22. O. fulviventris *Pz.* ♂, skg. (Thuringia); 23. O. fusca *Chr.*, skg. legitimately, and dusting its head with pollen; 24. O. rufa *L.* ♂, do. **C. Lepidoptera.** (*a*) *Noctuidae*: 25. Plusia gamma *L.*, climbing from below and skg. (*b*) *Rhopalocera*: all skg.; 26. Coenonympha pamphilus *L.*; 27. Syrichthus alveolus *Hb.*; 28. Nisoniades tages *L.* (Budd., Nassau); 29. Papilio podalirius *L.*; 30. Pieris brassicae *L.*; 31. P. napi *L.*; 32. P. rapae *L.*; 33. Rhodocera rhamni *L.* (*c*) *Sphingidae*: 34. Macroglossa fuciformis *L.*, skg.

Loew observed the following in Brandenburg ('Beiträge,' p. 62).—

A. Diptera. *Tabanidae*: 1. Tabanus tropicus *L.* ♂, skg. and (?) effecting pollination. **B. Hymenoptera.** *Apidae*: 2. Andrena schencki *Mor.* ♀, po-cltg.; 3. Anthophora aestivalis *Pz.* ♂, skg.; 4. A. pilipes *F.* ♀, do.; 5. Bombus cognatus *Steph.* ♀; 6. B. confusus *Schenck* ♀; 7. B. rajellus *K.* ♀; 8. Eucera longicornis *L.* ♂, skg.; 9. Halictus quadristrigatus *Ltr.* ♀, po-cltg.; 10. H. xanthopus *K.* ♀, skg.; 11. Melecta luctuosa *Scop.* ♀, do.; 12. Osmia bicornis *L.* ♀, do.; 13. O. uncinata *Gerst.* ♀, do.; 14. Sphecodes fuscipennis *Germ.* ♀, do.

The following were recorded by the observers, and for the localities stated.—

Knuth (Schleswig-Holstein), the honey-bee, skg., 3 humble-bees, skg. (1. Bombus agrorum *F.* ♀; 2. B. hortorum *L.* ♀; 3. B. lapidarius *L.* ♂), and a butterfly (Pieris napi *L.*), skg. (an unbidden guest). Wüstnei (Alsen), 2 bees—Bombus hortorum *L.*, and Andrena trimmerana *K.* Schmiedeknecht (Thuringia), 4 bees—

1. Bombus muscorum *F.*; 2. B. subterraneus L.; 3. Osmia caerulescens *L.* (=O. aenea *L.*); 4. O. emarginata *Lep.* Krieger (Leipzig), the bee Eucera longicornis *L.* ♂. Frey-Gessner (Switzerland), the dasygastrid bee Osmia rufohirta *Lep.* Ducke (Trieste), 2 bees—Osmia aurulenta *Pz.*, and O. bicolor *Schr.* MacLeod (Flanders), 4 humble-bees, a short-tongued bee, an ant, and a beetle (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 379): (Pyrenees), a hover-fly, and a Bombyliid (op. cit., iii, 1891, p. 337). Scott-Elliot (Dumfriesshire), a humble-bee, and 2 hover-flies ('Flora of Dumfriesshire,' p. 141).

2377. A. pyramidalis L. (Sprengel, 'Entd. Geh.,' p. 299; Herm. Müller, 'Alpenblumen,' pp. 307–8; Schulz, 'Beiträge,' II, p. 197; Ricca, Atti Soc. ital. sc. nat., Milano, xiii, 1870.)—This species is gynomonoecious with hermaphrodite flowers, which Hermann Müller describes as feebly protandrous, but Ricca as homogamous. The style is situated at first above the stamens, but bends down between the anthers after they have dehisced, thus bringing the stigma into the entrance, where it is first touched by every nectar-seeking visitor. Cross-pollination is therefore ensured when the flower is visited by insects: should such visits fail, automatic self-pollination is effected as in A. reptans.

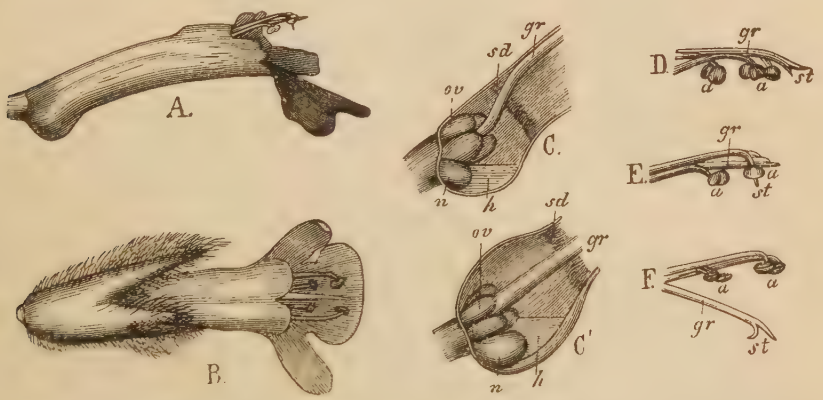


FIG. 342. *Ajuga pyramidalis*, *L.* (after Herm. Müller). *A.* Completely developed flower; seen from the side after removal of the calyx. *B.* Do., with calyx, seen from above (× 4). *C.* Lower part of the corolla-tube, cut open from the side. *C'.* Do. of *A. genevensis*, *L.* (× 7). *D.* Relative positions of stamens and stigma in a young flower. *E.* Do. in a mature flower. *F.* Do. in an old flower (× 7). *a*, anthers; *gr*, style; *h*, nectar; *n*, nectary; *ov*, ovary; *sd*, nectar-cover; *st*, stigma.

In addition to these protandrous hermaphrodite flowers, Schulz observed in the South Tyrol sporadic gynomonoeciously distributed female ones.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 3 humble-bees, skg. (with proboscides 9–13 mm. long), and a hover-fly, po-dvg. Loew (Berlin Botanic Garden), on the hybrid A. pyramidalis *L.* × A. reptans *L.*, a humble-bee (Bombus agrorum *F.* ♀, steadily skg.), and a saw-fly (Athalia rosae *L.*, freq. on flowers and leaves, not skg.).

2378. A. genevensis L. (Herm. Müller, 'Alpenblumen,' pp. 308–9; Schulz, 'Beiträge,' II, p. 222; Kirchner, 'Flora v. Stuttgart,' pp. 636–7.)—The mechanism of the protandrous, blue, hermaphrodite flowers of this species, which are arranged in long, conspicuous inflorescences, resembles that of A. pyramidalis, the style being

at first situated above the anthers and sinking down between them later on. Thus if insect-visits fail, automatic self-pollination is easily effected. The nectary, which, as in other species of this genus, is situated on the front of the ovary, is very strongly developed, and the secretion of nectar therefore extremely abundant. (*Cf.* Fig. 342, *C'*.)

Schulz observed perforation by humble-bees.—

Visitors.—Schletterer gives the following list for Pola.—

Hymenoptera. (*a*) *Apidae*: 1. Anthidium septemdentatum *Ltr.*; 2. Andrena carbonaria *L.*; 3. A. convexiuscula *K.*, var. fuscata *K.*; 4. A. flavipes *Pz.*; 5. A. parvula *K.*; 6. A. thoracica *F.*; 7. Ceratina cucurbitina *Rossi*; 8. Eucera interrupta *Baer.*; 9. E. longicornis *L.*; 10. Halictus calceatus *Scop.*; 11. H. quadricinctus *F.*; 12. H. scabiosae *Rossi*; 13. H. tetrazonius *Klg.*; 14. Megachile (Chalicodoma) manicata *Gir.*; 15. M. (C.) muraria *Retz.*; 16. Osmia caerulescens *L.*; 17. O. emarginata *Lep.*; 18. O. versicolor *Ltr.*; 19. Podalirius acervorum *L.*; 20. P. crinipes *Sm.*; 21. P. retusus *L.*, var. meridionalis *Pér.*; 22. P. tarsatus *Spin.* (*b*) *Tenthredinidae*: 23. Athalia rosae *L.*, var. cordata *Lep.*; 24. A. spinarum *F.*

Herm. Müller (Alps) saw 3 humble-bees and 2 Lepidoptera; Friese (Thuringia), 2 bees—Andrena carbonaria *L.*, and Osmia andrenoides *Spin.*

2379. A. Chamaepitys Schreb.—

Visitors.—Schletterer observed 4 bees at Pola.—Three po-cltg. species—

1. Anthidium manicatum *L.*; 2. A. oblongatum *Ltr.*; 3. Osmia andrenoides *Spin.*; and the parasitic form—4. Pasites maculatus *Jur.*

736. Teucrium L.

Protandrous bee flowers, apparently without an upper lip, this being deeply bifid, and the halves united to the margin of the lower lip. There is no circlet of hairs in the corolla-tube. Kerner describes the middle lobe of the lower lip as arching over the anthers and stigma in the bud like a hollow hemisphere, and then curving downwards when the flower opens. Nectar secreted and concealed as usual. Sometimes gynomonoecism.

2380. T. Scorodonia L. (Delpino, 'Ult. oss.'; Herm. Müller, 'Fertilisation,' pp. 499–500, 'Weit. Beob.' III, p. 44; Kirchner, 'Flora v. Stuttgart,' pp. 637–8; Schulz, 'Beiträge,' II, p. 222; MacLeod, Bot. Centralbl., Cassel, xxiii, 1885, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 379–81; Knuth, 'Bloemenbiol. Bijdragen.')—The greenish-yellow flowers of this species are arranged in terminal and axillary unilateral racemes. The corolla-tube is 9–10 mm. long, its lower part often being filled with nectar to a height of 4 mm. At the beginning of anthesis the stamens—which lie against the back of the upper part of the corolla-tube—project straight out of the flower, together with the style, the stigmatic branches having already slightly diverged. The latter, however, are still behind the anthers, so that in the first stage of anthesis the head of a bee probing for nectar touches only the anthers. The stamens then bend upwards, and finally backwards and downwards, while the style curves forwards, its branches, which now diverge more widely, assuming the position previously occupied by the anthers.

When the lower flowers of an inflorescence are in the second (female) stage, the

upper ones are male, so that a bee sucking nectar, and working up from below, regularly crosses separate stocks. Humble-bees actually behave in this way. Hermann Müller points out that they work upwards on the unilateral inflorescence with the greatest regularity, without missing a single flower.

Should insect-visits fail, automatic self-pollination is only occasionally effected, the stigma sometimes brushing the anthers while still covered with pollen.

MacLeod says that gynodioecious plants occur in Luxemburg.

Schulz observed occasional perforation by humble-bees.

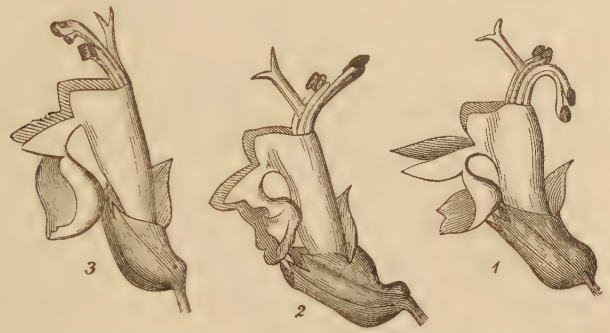


FIG. 343. *Teucrium Scorodonia*, *L.* (after Herm. Müller). (1) Flower in the first (male) stage. (2) Do., at the beginning of the second (female) stage. (3) Do., at the end of the second stage.

VISITORS.—Herm. Müller (H. M.) and Buddeberg (Budd.) give the following list.—

A. Diptera. *Syrphidae*: 1. Eristalis nemorum *L.*, po-dvg., occasionally effecting pollination by chance (H. M.). **B. Hymenoptera.** *Apidae*: 2. Anthophora quadrimaculata *Pz.* ♀ and ♂, skg. (H. M., Budd.); 3. Bombus agrorum *F.* ☿ and ♀, very numerous, skg. (H. M., Budd.); 4. B. hypnorum *L.* ♂ and ☿, skg. (H. M.); 5. B. lapidarius *L.* ☿, do. (H. M., Budd.); 6. B. muscorum *F.* ☿, do. (H. M.); 7. B. pratorum *L.* ☿ and ♀, freq., skg. (H. M.); 8. B. sylvarum *L.* ♂, skg. (Budd.); 9. Halictus morio *F.*, creeping into the flowers (Budd.); 10. Osmia aurulenta *Pz.* ♀, skg. (Budd.); 11. Psithyrus barbutellus *K.* ♂, in large numbers, skg. (H. M.); 12. Saropoda bimaculata *Pz.* ♀ and ♂, very common, skg. (H. M.).

Alfken saw 10, and Höppner 11 bees at Bremen.—

Alfken—1. Bombus agrorum *F.* ☿; 2. B. arenicola *Ths.*; 3. B. proteus *Gerst.* ♀; 4. B. sylvarum *L.* ☿; 5. B. variabilis *Schmiedekn.* ☿; 6. Megachile willughbiella *K.* ♀; 7. Podalirius borealis *Mor.* ♀ and ♂; 8. P. furcatus *Pz.* ♂; 9. P. vulpinus *Pz.* ♀ and ♂; 10. Psithyrus vestalis *Fourcr.* ♀, skg. Höppner—1. Apis mellifica *L.* ☿; 2. Bombus agrorum *F.* ♀; 3. B. arenicola *Ths.* ♀; 4. B. hortorum *L.*; 5. B. lapidarius *L.*; 6. B. sylvarum *L.*; 7. Eucera difficilis (*Duf.*) *Pér.*; 8. Podalirius borealis *Mor.* ♀ and ♂; 9. P. furcatus *Pz.* ♀; 10. P. retusus *L.* ♀; 11. P. vulpinus *Pz.* ♀.

The following were recorded by the observers, and for the localities stated.—

Knuth (Westphalia), the honey-bee, in very large numbers, skg. Loew (Berlin Botanic Garden), the humble-bee Bombus terrester *L.* ♂, skg. Schenck (Nassau), the bee Anthidium manicatum *L.* MacLeod (Pyrenees), 3 humble-bees (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 337–8), (Flanders), 5 bees (1. Apis mellifica *L.* ☿, freq.; 2. Bombus terrester *L.*, very freq.; 3. B. muscorum *F.* do.; 4. Coelioxys conica *L.*; 5. Eucera longicornis *L.*), and 2 butterflies (Epinephele janira *L.*, and

Pieris napi *L.*). H. de Vries (Netherlands), the humble-bee Bombus agrorum *F.* ♀ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875). Willis (neighbourhood of south coast of Scotland), 4 bees, skg. ('Fls. and Insects in Gt. Britain,' Part I)—1. Bombus agrorum *F.*, freq.; 2. B. hortorum *L.*; 3. B. terrester *L.*, freq.; 4. Psithyrus campestris *Pz.* Scott-Elliot (Dumfriesshire), the honey-bee, 5 humble-bees, and a hover-fly ('Flora of Dumfriesshire,' p. 141).

2381. T. Chamaedrys L. (Herm. Müller, 'Alpenblumen,' pp. 309–11; Schulz, 'Beiträge,' II, pp. 197, 222; Loew, 'Blütenbiol. Floristik,' p. 400; Kirchner, 'Flora v. Stuttgart,' p. 638.)—The mechanism of the purple-red flowers of this species agrees essentially with that of T. Scorodonia, but the stamens do not bend back so far. Hermann Müller states that the style is about the same length as the short stamens; Schulz, however, says that it now and then projects 1–3 mm. beyond the long stamens, so that automatic self-pollination is excluded in such flowers. It can be effected in those with short styles, for the stigma is dusted with pollen still clinging to the anthers as it glides between them. A proboscis of 7–10 mm. is necessary in order to suck all the nectar.

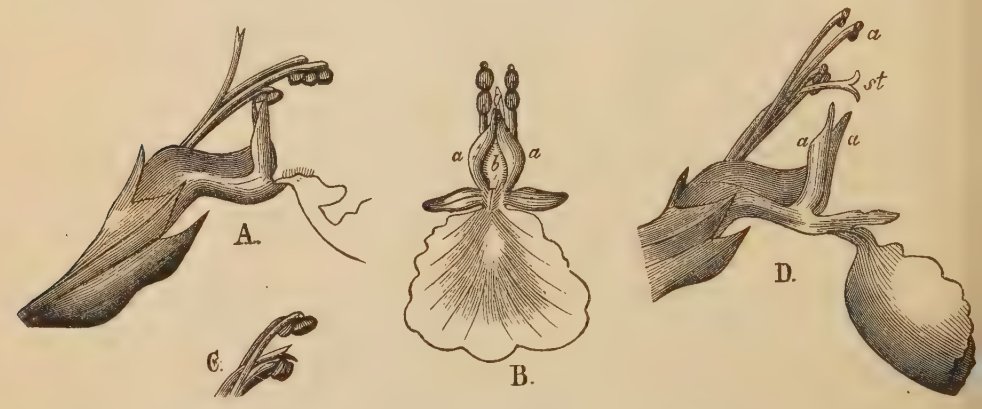


FIG. 344. *Teucrium Chamaedrys*, *L.* (after Herm. Müller). *A.* Flower in the first (male) stage, seen from the side. *B.* Do., in a state of transition between the first (male) and the second (female) stage, seen directly from the front. *C.* Reproductive organs of the same flower, seen from the side. *D.* Flower in the second (female) stage, seen from the side (× 4). *a* (upper), anthers; *a* (lower), uppermost lobes of the corolla; *b*, entrance of the flower; *st*, stigma.

Schulz observed occasional female flowers among the protandrous hermaphrodite ones. He also found flowers perforated by Bombus terrester, which as a rule sucks legitimately.

VISITORS.—Schletterer gives for the Tyrol (T.), and observed at Pola, the following.—

Hymenoptera. (*a*) *Apidae*: 1. Anthidium diadema *Ltr.*; 2. A. florentinum *F.*, one ♀; 3. A. variegatum *F.*; 4. Bombus hortorum *L.* (T.); 5. B. terrester *L.*; 6. B. zonatus *Sm.*, one; 7. Coelioxys aurolimbata *Först.*; 8. C. conoidea *Ill.*; 9. Eucera interrupta *Baer.*; 10. Halictus major *Nyl.* (T.); 11. Megachile lefeburei *Lep.*; 12. Melecta funeraria *Sm.*; 13. M. luctuosa *Scop.*; 14. Podalirius retusus *L.*, var. meridionalis *Pér.* (*b*) *Scoliidae*: 15. Scolia haemorrhoidalis *F.*

The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 4 long-tongued bees and a Lepidopterid. Loew (Alps), a long-tongued bee (Anthophora sp.), skg.; (Berlin Botanic Garden), the butterfly

Pieris brassicae *L.*, skg., and 3 bees, skg.—1. Bombus agrorum *F.* ♀, skg.; 2. B. terrester *L.* ♂, skg.; 3. Psithyrus rupestris *F.* ♂, skg. Friese (Thuringia and Hungary), the rare parasitic bee Dioxys tridentata *Nyl.* von Dalla Torre (Tyrol), 3 bees—1. Bombus hortorum *L.* ☿; 2. B. variabilis *Schmiedekn.* (= B. tristis *Seidl.*), very numerous; 3. Halictus major *Nyl.* ♀. MacLeod (Pyrenees), the humble-bee Bombus agrorum *F.* (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 338).

2382. T. montanum L. (Herm. Müller, 'Alpenblumen,' p. 311.)—The whitish flowers of this species are protandrous, but the movement of stamens and style is still feebler than in T. Chamaedrys. A proboscis of 6 mm. long is able to suck all the nectar, which is therefore accessible to the honey-bee.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), the honey-bee, 6 humble-bees, and a Lepidopterid. Friese (Thuringia), 2 po-cltg. bees (Osmia andrenoides *Spin.*, and O. montivaga *Mor.*), the rare parasitic bee Stelis nasuta *Ltr.*, and the true wasp Celonites abbreviatus *Vill.* Schmiedeknecht (Thuringia), the bee Osmia andrenoides *Spin.*

2383. T. Botrys L. (Herm. Müller, 'Weit. Beob.,' III, p. 45; Kirchner, 'Flora v. Stuttgart,' p. 369; Knuth, 'Bloemenbiol. Bijdragen.')—The flowers of this species are bright purple in colour, the middle lobe of the lower lip being yellowish-white with purple spots.

In the plants I examined in the Kiel Botanic Garden (29. 8.'96) anthesis was almost at an end, so that I could not observe its first stage. The stamens do not bend back, for towards the end of anthesis the stigma is situated between the pairs of anthers, so that pollen can fall upon it and automatic self-pollination be effected. The corolla-tube is 5 mm. long and entirely enclosed in the ventricose calyx.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Thuringia), 2 bees, skg.—Anthidium manicatum *L.* ♂, and A. punctatum *Ltr.* ♂. Schletterer and von Dalla Torre (Tyrol), the bee Sphecodes fuscipennis *Germ.* ♀.

2384. T. Scordium L. (Herm. Müller, 'Weit. Beob.,' III, pp. 44–5.)—The corolla-tube of the strongly protandrous purple-red flowers of this species is only 4 mm. long, and entirely surrounded by the calyx. The pointed lateral lobes (3 mm. long) of the upper lip (which serves as an alighting-platform, and is 7–8 mm. long), guide the proboscis of bees probing for nectar. The stamens and style project obliquely upwards from the corolla-tube, in the same relative positions at first as in T. Scorodonia. In the second (female) stage the stamens, however, only bend back so far that the anthers are situated vertically above the slightly downwardly bent stigma, when automatic self-pollination can be effected by the fall of pollen. Warnstorf describes the pollen-grains as white in colour, ellipsoidal, delicately tuberculate, up to 56 μ long and 25 μ broad.

Visitors.—Herm. Müller saw 2 bees, skg.—Apis mellifica *L.* ☿, and Saropoda bimaculata *Pz.*

2385. T. pyrenaicum L. (MacLeod, 'Pyreneënbl.,' pp. 63–8, Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 338–43.)—This species bears homogamous bee flowers, which possibly possess a Lepidopterid door. The lower lip is pale yellow,

almost white; the upright part of the corolla is violet, sometimes pale yellow. The lateral lobes are sickle-shaped and grooved, and the lower one possesses a central depression at its base. The three grooves converge towards the entrance to the corolla-tube, and are continued into this between two hairy ridges. The front margins of the two upper corolla-lobes form a kind of helmet bounding two entrances to the flower: the lower, triangular one is for humble-bees, but it is so narrow that a visitor of the kind is obliged to force the upper corolla-lobe upwards; this resumes its original position by the help of an elastic rib serving as a hinge. The upper entrance is narrow and oblong, provided with stiff hairs directed outwards, and is considered by MacLeod to be a Lepidopterid door. The style is longer than the stamens, so that the stigma is touched by insect visitors before the anthers, cross-pollination being therefore inevitable. Automatic self-pollination is generally excluded.

Visitors.—MacLeod observed 4 humble-bees.

2386. T. canum Fisch. et Mey (= T. Chamaedrys *L.*, according to the *Index Kewensis*).—

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Diptera. *Syrphidae*: all po-dvg.: 1. Melithreptus menthastri *L.*; 2. Syritta pipiens *L.*; 3. Syrphus pyrastri *L.* **B. Hymenoptera.** *Apidae*: 4. Anthidium manicatum *L.* ♀ and ♂; 5. Anthophora quadrimaculata *F.* ♀, skg.; 6. Bombus agrorum *F.* ♂ and ♀, do.; 7. B. cognatus *Steph.* ♀, do.; 8. B. terrester *L.* ☿ and ♂, do.; 9. Psithyrus rupestris *F.* ♂; 10. P. vestalis *Fourcr.*, skg. **C. Lepidoptera.** *Rhopalocera*: 11. Pieris brassicae *L.* skg.

2387. T. orientale L.—

Visitors.—Morawitz observed the bee Podalirius siewersi *Mor.* in the Caucasus.

2388. T. flavum L.—

Visitors.—Schletterer observed the following 5 bees at Pola.—

1. Anthidium diadema *Ltr.*; 2. Ceratina cucurbitina *Rossi*; 3. Eucera hispana *Lep.*; 4. Megachile argentata *F.*; 5. Podalirius quadrifasciatus *Vill.*, var. garrulus *Rossi*.

2389. T. Polium L.—

Visitors.—Schletterer observed the following at Pola.—

Hymenoptera. (*a*) *Apidae*: 1. Andrena morio *Brull.*; 2. Halictus variipes *Mor.*; 3. H. vestitus *Mor.*; 4. Megachile sericans *Fonsc.* (*b*) *Chalcididae*: 5. Leucaspis gigas *F.*, not infreq. (*c*) *Scoliidae*: 6. Scolia hirta *Schr.*; 7. S. insubrica *Scop.*, freq.; 8. S. quadripunctata *F.*; 9. S. quinquecincta *F.*, not infreq. (*d*) *Sphegidae*: 10. Ammophila heydeni *Dahlb.*; 11. Cerceris cornigera *Dahlb.*; 12. Sphex maxillosus *F.* (*e*) *Vespidae*: 13. Odynerus modestus *Sauss.*; 14. Polistes gallica *L.*

737. Blephilia Rafin.

2390. B. hirsuta Benth.—

Visitors.—Loew (Berlin Botanic Garden) observed a bee (Apis mellifica *L.*, ☿, skg.) and a butterfly (Pieris brassicae *L.*, skg.).

LXXXIII. ORDER *PLANTAGINACEAE* JUSS.

Literature.—Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 125, 'Grundriss d. Blütenbiol.,' p. 87.

Protogynous anemophilous flowers with long, flexible filaments and feathery stigmas. Hermaphrodite or monoecious.

738. Littorella Berg.

Monoecious. In the male flowers the four stamens are inserted into the corolla-tube. Two female flowers are situated at the base of each male.

2391. L. juncea Berg. (= L. lacustris *L.*). (Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 125; Braun, Bot. and Phys., Mem. Ray Society, London, 1853.)—The versatile anthers in this species are borne on slender filaments, and often project 2 cm. from the flower, swaying about in every breeze, so that the powdery pollen is easily carried away. The feathery stigmas of the female flowers situated at the base of the male ones are long and projecting, and mature before the anthers of the male flowers on the same plant dehisce. Submerged plants do not flower, but propagate by long runners (sometimes up to a dm. in length). A. Braun says that this always takes place in wet years, for then the plants all remain submerged.

Willis and Burkill ('Fls. and Insects in Gt. Britain,' Part I, p. 265) add to my description that the flowers are situated in groups of three, one stalked male in the middle and two sessile female ones at its base. The filaments are long and flexible, the anthers very versatile, and the stigmas long and penicillate. The female flowers mature earlier than the males of the same plant, so that self-pollination is prevented.

739. Plantago L.

Literature.—Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 125–6; Darwin, J. Linn. Soc., Bot., London, vi, 1862; Kuhn, Bot. Ztg., Leipzig, xxv, 1867, p. 67.

Flowers hermaphrodite, protogynous, with persistent stigmas. Sometimes synomonoecism or gynodioecism, rarely andromonoecism or androdioecism. Darwin says that some species are dimorphous, while others, according to Kuhn, bear cleistogamous flowers (e. g. P. virginica *L.*).

All the species which I examined bore only one whorl of mature flowers on the spicate inflorescences. The slender, flexible filaments project some millimetres from the flower, only the backs of the versatile anthers being attached to their tips. The filaments are generally brownish in P. major *L.*, whitish in P. lanceolata *L.*, and P. arenaria *Waldst. et Kit.*, yellow in P. maritima *L.* and P. Coronopus *L.*, and violet in P. media *L.* These colours make the inflorescences tolerably conspicuous, especially in P. media *L.* Pollen-devouring or pollen-collecting insects may therefore (though rarely) be seen on these flowers, so that entomophily may occasionally be effected. Flies are the most frequent visitors; the delicate scent of P. media *L.* so adds to its attractiveness that humble- and honey-bees also visit it.

Pollination is, however, much more frequently effected by wind. The somewhat feathery stigmas project from the otherwise entirely closed bud; the stamens then mature, while the stigma still remains receptive, so that automatic self-pollination is

brought about if cross-pollination fails. Pollen from flowers on other plants is not necessary, as those in the first stage may be crossed with that of others with mature stamens situated lower on the spike. I observed regularly also that in P. maritima the stigma not only persisted through the whole hermaphrodite stage, but even elongated several millimetres and remained receptive some time after the stamens faded. Geitonogamy may therefore occur in the last stage, the pollen of flowers at the top of the inflorescence falling on the stigmas of those situated lower.

Kerner says that the anthers dehisce upwards by means of a short slit only, so that some days elapse before the pollen is shaken out. The dehisced anther-lobes close during dewy nights and damp weather, thus preventing the pollen from being spoilt by wet. Pollen-collecting bees damp the dry pollen-grains with regurgitated nectar.

2392. P. major L. (Schulz, 'Beiträge,' II, pp. 152–3, 197; Kirchner, 'Flora v. Stuttgart,' p. 647.)—Schulz states that this species varies between homogamy and protogyny; the length of the style is also frequently variable. Most stocks possess brownish corollas, white filaments, and red-brown anthers; Ludwig, however, says that forms occur with yellow or greenish-yellow anthers, which are larger and broader and more rounded at the top. Stocks with white anthers are found rarely. Schulz observed gynomonoecism and gynodioecism, but the number of female flowers is small, and seldom exceeds 10 %.

2393. P. lanceolata L. (Delpino, 'Applicaz. d. teor. Darwin.,' p. 6; Herm. Müller, 'Fertilisation,' pp. 503–6; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 362; Schulz, 'Beiträge,' I, pp. 90–2, II, pp. 174–98; Kirchner, 'Flora v. Stuttgart,' pp. 646–7; Knuth, 'Blütenbesucher,' p. 9, 'Blütenbiol. Beob. in Thüringen,' 'Bloemenbiol. Bijdragen.')—This species is gynodioecious and gynomonoecious with protogynous hermaphrodite flowers. The receptive stigma projects about a mm. from the hermaphrodite flowers before the corolla opens, while the anthers, of which the filaments are still short, are enclosed in the bud. When the stigma begins to shrivel, the filaments elongate and project 5–6 mm. from the flower when the transparent corolla opens, the anthers dehiscing and scattering their pollen at the same time.

Schulz states, however, that the hermaphrodite flowers are not always so strongly protogynous, but in many cases the stigma only matures when anthesis begins. The length of the style varies.

Ludwig distinguished (in 1879) two forms: in one the anthers were white and heart-shaped, in the other they were oblong; their colour varied between greenish and sulphur-yellow, and their pollen-grains were generally reduced.

Hermann Müller describes two forms, united by transition stages.

(1) Low-growing plants, found in sunny, hilly stations; these bear rounded spikes 5 mm. in diameter, with stalks which are often scarcely 10 cm. long. The anthers project 5–6 mm. from the flower.

(2) Tall plants, growing on alluvial meadows, bearing spikes 15–30 mm. long with stalks 30–44 cm. in length. The anthers project 6–7 mm. from the flower.

Delpino distinguishes three forms.

(1) Long-scaped plants growing in meadows, with very broad whitish anthers

easily shaken by the wind. These flowers seem to be exclusively anemophilous, for Delpino never saw them visited by insects.

(2) Plants with shorter scapes, which also seem to be almost exclusively anemophilous, for Delpino only once saw a Halictus collecting pollen on the inflorescences.

(3) A dwarf mountain form, with short spikes and stamens. Delpino observed numerous bees collecting pollen, while the Halictus mentioned above could only collect a small amount, most of it falling to the ground.

Delpino concluded from this last observation that the structure of the flowers is unsuited for pollen-collecting bees. Hermann Müller rightly observes, however, that Delpino has possibly taken for granted certain adaptations in the third form (on which he saw the honey-bee collecting pollen) which are not actually present, simply because of the abundant pollen collected by the honey-bee. This, however, results from this bee's habit of smearing the pollen with nectar.

FIG. 345. *Plantago lanceolata*, *L.* (after Herm. Müller). (1) Flower in the first (female) stage; petals and stamens still enclosed in the bud. (2) Do., after removal of the calyx. (3) An anther from the same flower. (4) Flower in the second (male) stage. (5) The cohering lower sepals. (6) A lateral sepal.

Gynomonoeciously or gynodioeciously distributed female flowers occur now and then in addition to the hermaphrodite ones. Schulz says that they are usually 20–25 %, and sometimes even 50 %. The flowers of purely female stocks have either yellow anthers with reduced pollen, or no anthers at all. They are more fertile than the hermaphrodite flowers, and only appear (according to Ludwig) towards the end of the flowering season. Different zones of flowers can be recognized on the spikes of gynomonoecious stocks, one bearing purely female flowers, another hermaphrodite ones, and the third of intermediate character with occasional reduced stamens.

VISITORS.—Hermann Müller in Westphalia, and myself in Schleswig-Holstein, saw the honey-bee as a pollinator. Hermann Müller gives the following account (with which my own observations agree) of the way in which it visits the flowers (op. cit., pp. 505–6).—

'The honey-bee flies buzzing to a spike, and while it hovers in the air it spits a little honey on the exserted anthers. Then, still hovering and buzzing, it brushes pollen with the tarsal brushes of its forefeet off the anther, the tone of its humming becoming suddenly higher; in the same instant one sees a cloud of pollen rise from the shaken anthers. After placing the pollen on its hindlegs the bee repeats the operation on the same or other spikes, or if it is tired it alights on the spike and creeps upward. Since the scattered pollen in part reaches the stigmas of the same or neighbouring plants, we have here anemophilous flowers fertilized also by insects.'

In windy weather the honey-bee behaves quite differently when collecting pollen.

In these circumstances it flies straight to the spikes, goes once round the zone containing opening flowers, and brushes its legs over the projecting anthers. It is thus able, after the loosely-placed pollen has been dispersed by the wind, to obtain still further supplies. Honey-bees vary individually in their treatment of these anemophilous flowers. Thus Hermann Müller observed one which hovered buzzing and with outstretched proboscis in front of the flowering spike, but gripped it firmly with its feet each time when collecting pollen ('Weit. Beob.,' III, pp. 63–4).

Herm. Müller gives the following list.—

A. Diptera. *Syrphidae*: 1. Melanostoma mellina *L.*, very common, po-dvg.; 2. Syrphus ribesii *L.*, repeatedly, po-dvg.; 3. Volucella pellucens *L.*, po-dvg. **B. Hymenoptera.** *Apidae*: 4. Apis mellifica *L.* ☿, very common, po-cltg.; 5. Bombus pratorum *L.* ☿, po-cltg.; 6. Halictus sp., working at the anthers.

The following were recorded by the observers, and for the localities stated.—

Knuth (Röm), the po-dvg. hover-fly Helophilus pendulus *L.*: (Friederichsroda, Thuringia, July, '94), the humble-bee Bombus terrester *L.* ☿, po-cltg. MacLeod (Flanders), the hover-fly Melanostoma mellina *L.*, po-dvg. (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 371). Scott-Elliot (Dumfriesshire), the honey-bee, a humble-bee, a hover-fly (rare), and a Lepidopterid ('Flora of Dumfriesshire,' p. 334).

2394. P. media L. (Darwin, 'Forms of Flowers,' p. 307; Ludwig, Zs. Ges. Natw., Berlin, lii, 1879, pp. 441–9; Herm. Müller, 'Fertilisation,' pp. 506–8, 'Alpenblumen,' p. 357, 'Weit. Beob.,' III, p. 64; Knuth, 'Blütenbesucher,' pp. 9–10, 'Blütenbiol. Herbstbeob.,' 'Bloemenbiol. Bijdragen'; Kirchner, 'Flora v. Stuttgart,' pp. 647–8; Schulz, 'Beiträge,' I, pp. 92–3, II, p. 198.)—This species exhibits gynodioecism, gynomonoecism, andromonoecism, and androdioecism with protogynous hermaphrodite flowers. We have here a transition between anemophily and entomophily, to express which I have employed the term 'wind flowers' (*cf.* Vol. I, p. 69). The violet colour of the stamens and the delicate odour of the whorled flowers attract numerous visitors, including humble- and honey-bees. Hermann Müller tried to distinguish between two forms, one predominantly anemophilous, the other mainly entomophilous.—

(*a*) var. *anemophila* Knuth. Long scapes, with spikes of about 4 cm. elongating to 7–8 cm. as they fade; the feebly curved filaments are white and project 7–9 mm. out of the flower; pollen powdery as in (*b*), but slightly less adhesive. Stigmas long; corolla-lobes pointed and spreading.

(*b*) var. *entomophila* Knuth. Shorter scapes of about 15 cm.; the stiff filaments shorter and reddish; pollen more adhesive than that of (*a*), but the grains here also are so smooth and dry that they are easily removed by wind. Ekstam states that in the Swedish Highlands this plants possesses a pleasant odour and reddish spikes as attractions, thus, in his opinion, deceiving insects such as humble-bees and flies. Stigmas project only slightly; corolla-lobes rounded and directed obliquely upwards.

Both forms are protogynous, but less strongly so than P. lanceolata, for the stigma is still receptive when the anthers dehisce. Schulz says that the degree of protogyny varies, and that the flowers may even be homogamous.

Gynodioecism was observed by Darwin in England, and by Ludwig in Thuringia

Schulz noticed not only gynodioecism, but also gynomonoecism, andromonoecism, and androdioecism.

Visitors.—Knuth observed (Kiel Botanic Garden) the butterfly Vanessa io *L.*, vainly searching for nectar, and the following in Thuringia (Eisenach, Coburg, and Schwarzburg), and in meadows at Cassel (July, '94).—

A. Coleoptera. (*a*) *Cerambycidae*: 1. Strangalia bifasciata *Müll.*, po-dvg. (*b*) *Nitidulidae*: 2. Meligethes sp., po-dvg. **B. Diptera.** *Syrphidae*: all po-dvg.: 3. Eristalis sp.; 4. Melanostoma mellina *L.*; 5. Rhingia rostrata *L.*; 6. Syrphus balteatus *Deg.*; 7. S. sp.; 8. Volucella pellucens *L.* **C. Hymenoptera.** *Apidae*: all po-cltg.: 9. Apis mellifica *L.*; 10. Bombus lapidarius *L.* ♀; 11. B. terrester *L.* ♀ and ♀; 12. Halictus cylindricus *F.*

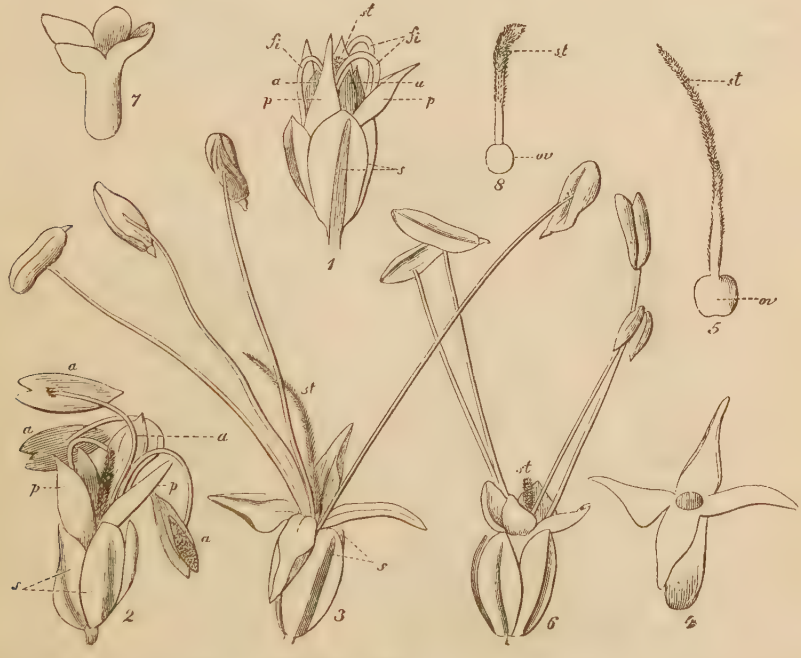


Fig. 346. *Plantago media*, *L.* (after Herm. Müller). (1–5) A form growing on dry sunny slopes at Rixberger Hill (Lippstadt). (1) Bud. (2) Opening flower. (3) Completely expanded flower. (4) Corolla. (5) Pistil. (6–8) Another form growing in damp and rather shady spots in the same locality. (6) Mature flower. (7) Corolla. (8) Pistil. *a*, anthers; *fi*, filaments; *ov*, ovary; *p*, petals; *s*, sepals; *st*, stigma.

Herm. Müller gives the following list, in which Budd. = Buddeberg, and T. = Thuringia.—

A. Coleoptera. (*a*) *Cerambycidae*: 1. Strangalia bifasciata *Müll.*, po-dvg. (T.); 2. S. nigra *L.*, in large numbers, gnawing the anthers. (*b*) *Telephoridae*: as 2: 3. Anthocomus fasciatus *L.*; 4. Malachius aeneus *L.* (*c*) *Nitidulidae*: 5. Meligethes, not infreq. (*d*) *Oedemeridae*: 6. Oedemera marginata *F.*, dvg. the anthers (T.). **B. Diptera.** (*a*) *Muscidae*: 7. Spilogaster semicinerea *Wied.*, very common, po-dvg. (*b*) *Stratiomyidae*: 8. Chrysomyia formosa *Scop.* (*c*) *Syrphidae*: all po-dvg.: 9. Ascia podagrica *F.*; 10. Chrysotoxum festivum *L.* (Kitzingen); 11. Eristalis arbustorum *L.*, very common; 12. Helophilus floreus *L.* (T.); 13. Melanostoma ambigua *Fall.*; 14. M. mellina *L.*; 15. Rhingia rostrata *L.* (H. M., Budd.);

16. Syrphus balteatus *Deg.*; 17. S. ribesii *L.* **C. Hymenoptera.** *Apidae*: 18. Andrena sp. ♀, repeatedly, po-cltg.; 19. Bombus terrester *L.* ♀, freq., po-cltg.; 20. Eucera longicornis *L.* ♂, vainly searching for nectar; 21. Halictus albipes *F.* ♀, repeatedly, po-cltg.; 22. H. cylindricus *F.* ♀, do.; 23. Megachile circumcincta *K.* ♀. **D. Lepidoptera.** *Tineidae*: 24. Micropteryx, sp., numerous (Budd.).

The following were recorded by the observers, and for the localities stated.—

Lindmann (Dovrefjeld), a nectar-seeking moth. Herm. Müller (Alps), 2 beetles, 5 flies, and 4 bees. MacLeod (Pyrenees), 2 short-tongued bees and a fly (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 323).

2395. P. montana Huds. (Schulz, 'Beiträge,' II, p. 198.)—The herbarium material of this species examined by Schulz bore a proportion of female flowers, and seemed to be protogynous and anemophilous.

2396. P. alpina L. (Herm. Müller, 'Alpenblumen,' pp. 256–7; Loew, 'Blütenbiol. Floristik,' p. 396; Kirchner, 'Beiträge,' p. 58.)—The reddish corolla-

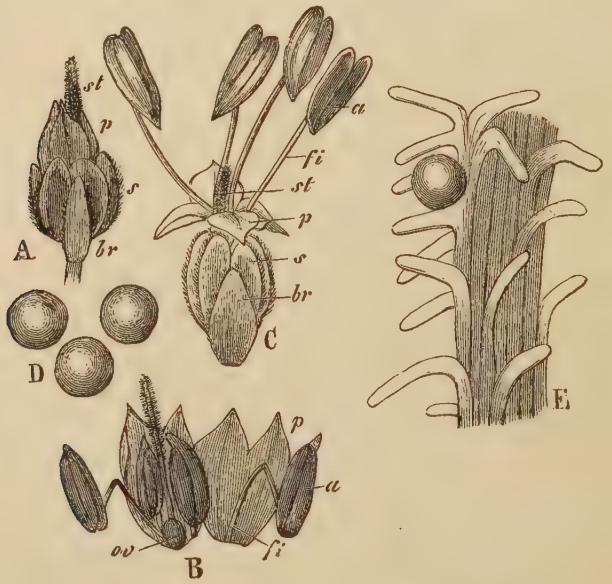


FIG. 347. *Plantago alpina*, *L.* (after Herm. Müller). *A.* A bud with projecting stigma, seen from the side. *B.* Do., with parts separated. *C.* A homogamous flower (× 7). *D.* Pollen-grains, further enlarged. *E.* A piece of the stigma. *a*, anthers; *br*, bract; *fi*, filaments; *ov*, ovary; *p*, corolla-lobes; *s*, sepals; *st*, stigma.

lobes render the anemophilous flowers of this species tolerably conspicuous, so that pollen-collecting insects are now and then attracted, and sometimes bring about fertilization. The course of maturation of stamens and stigma varies between homogamy and protogyny. The flowers observed by Kirchner near Zermatt were protogynous with persistent stigmas, which still remained receptive when the anthers dehisced.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), a humble-bee, a hover-fly (Melanostoma mellina *L.*), 3 Lepidoptera, and an earwig larva (Forficula). Loew (Switzerland), the hover-fly Didea intermedia *Loew*, po-dvg.

2397. P. serpentina Vill. (= P. maritima *L.*, according to the *Index Kewensis*).—This species agrees with the preceding one, but all its parts are larger.

2398. P. maritima L. (Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 125–6; Schulz, 'Beiträge,' II, p. 198.)—In this species the stigma projects from the bud, persists throughout the maturation of the stamens, and was still receptive after the anthers had faded in plants which I examined in the North Frisian Islands. Schulz observed gynomonoecism and gynodioecism, generally 5–10 %, rarely up to 20 %.

2399. P. Coronopus L. (Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 125; Ludwig, 'Lehrbuch d. Biol. d. Pfl.')—This species, again, is strongly protogynous with persistent stigmas in the North Frisian Islands. Ludwig observed transitions to gynodioecism, and also found heteranthery, i.e. two kinds of anthers, resembling those in P. major.

2400. P. borealis L.—Warming describes this species as anemophilous.

2401. P. arenaria Waldst. et Kit. (Kirchner, 'Beiträge,' p. 58; Knuth, 'Bloemenbiol. Bijdragen.')—The flower mechanism in cultivated plants of this species agrees essentially with that of hermaphrodite flowers of P. lanceolata. In the first stage the filiform red stigma projects 3 mm. from the closed bud-like flower, while the anthers, on short filaments, are situated at its base. Later on the calyx opens, the inconspicuous corolla unfolds, and the dehiscing anthers project 4 mm. from the flower, borne on the fully-elongated filaments, which are much attenuated above. The stigma is now faded.

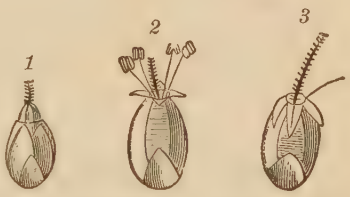


FIG. 348. *Plantago maritima*, *L.* (from nature). (1) Flower in the first female stage; the already receptive stigma is projecting from the still apposed corolla-lobes. (2) Do. in the hermaphrodite stage; the stamens with their dehiscing anthers project as well as the papillose stigma. (3) Do. in the second female stage; the still receptive stigma projects, as well as a filament which has lost its anther; the corolla-lobes are reflexed.

VISITORS.—Knuth (Kiel Botanic Garden) saw the hover-fly Melanostoma mellina *L.*, po-dvg.

2402. P. Cynops L. (Kirchner, 'Beiträge,' pp. 58–9.)—The flower mechanism of this species is the same as that of P. arenaria. In the first (female) stage the stigma projects 4 mm. from the flower, and in the second (male) stage the anthers protrude 8 mm.

2403. P. Lagopus L. (Ludwig, Bot. Centralbl., Cassel, iii, 1880, p. 829.)—Ludwig describes this species as gynodioecious.

2404. P. virginica L. (Ludwig, op. cit., iii, pp. 862–3.)—Ludwig describes cultivated plants of this species as possessing cleistogamous flowers.

LXXXIV. ORDER *NYCTAGINEAE* JUSS.

740. Oxybaphus L'Hérit.

2405. O. viscosus L'Hérit. (Heimerl, Verh. Zool.-Bot. Ges., Wien, xxxviii, 1888.)—Heimerl describes three stages of anthesis in this species: (1) The stigma is receptive. (2) The anthers dehisce, and self-pollination becomes possible. (3) The anthers, still covered with pollen, brush the stigma.

741. Mirabilis Riv.

2406. M. Jalapa L. (Heimerl, op. cit.; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 212 and 357.)—Heimerl describes the mechanism of this species as agreeing with that of the preceding one. Kerner says that the flowers open between 7–8 p.m. The stigma is then receptive, while the anthers do not dehisce until 10–15 minutes later: there is thus only a very short time between the two stages. Autogamy finally takes place in this night flower, by the rolling up of the filaments and style; the perianth, now becoming pulpy, forms a kind of cork over the tangle constituted by the thread-like filaments and the style.

Visitors.—Junger noticed especially the hawk-moth Sphinx convolvuli *L.* (Herm. Müller, 'Weit. Beob.,' II, p. 223.)

742. Acleisanthes A. Gray.

2407. A. longiflora A. Gray (= Mirabilis longiflora *L.*).—Heimerl says that the flowers of this species are probably adapted for pollination by nocturnal hawk-moths. Sprengel ('Entd. Geh.,' p. 121) concluded from the nectar-guides that they were day flowers, but this is doubtful, on account of the fragrance perceptible at night.

2408. A. Wrightii A. Gray. (Heimerl, op. cit.)—This species bears cleistogamous flowers.

743. Ambronia L.

2409. A. umbellata Lam. (Heimerl, op. cit.)—Flowers of this species are capable of self-fertilization.

744. Allionia Loefl.

Kerner states ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 304) that in species of this genus the stigma is situated at first at the end of the outstretched projecting style in front of the anthers, so that an insect visitor must first brush against it. Later on the style bends to the side at an angle of 80–90°, removing the stigma from the line of approach to the nectar, and thus enabling the visitor to touch the anthers.

2410. A. violacea L. (= Oxybaphus violaceus *Choisy*). (Kerner, op. cit., II, p. 357.)—The flowers of this species are protogynous, and autogamy occurs after a few hours by the rolling up of the filaments and style.

745. **Pison** Plum.

2411. P. hirtella H. B. et K.—Delpino ('Altri appar. dicog. recent. oss.') says that this species is protogynous. The stigmas project some millimetres from the flower during the first stage of anthesis, and the anthers during the second stage.

746. **Neea** Ruiz et Pav.

2412. N. theifera Oerst.—This species, according to Warming (Bot. Tids., Kjöbenhavn, ii, 1877) and Oersted (Bot. Ztg., Leipzig, xxvii, 1869, pp. 217–24), is diclinous.

LXXXV. ORDER *ILLECEBRACEAE* R. BR.

(including Paronychieae St. Hib., and Scleranthaceae Lindl.).

Flowers very small, homogamous; often cleistogamous or pseudocleistogamous.

747. **Herniaria** L.

Small inconspicuous flowers, with exposed nectar secreted in the base of the flower.

2413. H. glabra L. (Herm. Müller, 'Weit. Beob.,' II, pp. 223–4; Schulz, 'Beiträge,' II, p. 74.)—Even though the minute yellow flowers of this species are apetalous, they are conspicuous at some distance because many are associated. Hermann Müller states that 'half of the ten stamens are vestigial and devoid of anthers. The bases of the filaments are united to form a ring which secretes nectar from its inner surface, and surrounds the base of the style. Soon after the flowers open the anthers dehisce and turn their pollen-covered surfaces inwards. The two styles still lie together, but their upper ends are already beginning to diverge, and the stigmas are already receptive, so that automatic self-pollination may take place. When the anthers have shed all their pollen the styles diverge widely. Should insects visit the flowers, cross-pollination is favoured. According to Schulz, the styles usually diverge, even while the horizontal anthers are dehiscing, so that automatic self-pollination is almost inevitable.

Visitors.—In accordance with the small size of the flower, these are minute flies, Ichneumonids, ants, and beetles (Schulz).

Herm. Müller saw an ant (Myrmica levinodis *Nyl.* ☿) nect-lkg., visiting numerous flowers one after the other, and so effecting cross-pollination.

2414. H. alpina Vill.—Kirchner describes this species as homogamous, and automatic self-pollination may readily take place.

2415. H. hirsuta L.—This species also, according to Delpino, is homogamous Automatic self-pollination is inevitable as the anthers lie upon the stigmas.

748. **Illecebrum** Rupp.

2416. I. verticillatum L.—Warming states that the silver-white cartilaginous bracts of this species contain air-conducting tracheides. Automatic self-pollination

readily takes place in the homogamous flowers. In submerged blossoms this is effected pseudo-cleistogamously (Hansgirg), or cleistogamously (Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.,' p. 77), and always in a closed air-chamber (Kerner).

749. Polycarpon Loefl.

2417. P. tetraphyllum L.—The minute flowers of this species (only 2 mm. broad) are always closed like buds, and according to Batalin, have five boat-shaped sepals winged on the back, while the petals are scarcely visible. Fertilization is effected cleistogamously (Batalin).

750. Corrigiola L.

2418. C. littoralis L. (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The small, white flowers of this species are arranged in crowded spikes, and for the most part remain closed (pseudo-cleistogamous). The anthers are dark violet in colour and dehisce laterally. They project beyond the stigma, and autogamy is therefore brought about. The pollen-grains are pale yellow in colour, smooth, spheroido-tetrahedral, only 10–12 μ in diameter.

751. Paronychia L.

2419. P. capitata Lam. Flowers white.

Visitors.—Macleod (Pyrenees) saw Hymenoptera (1) and Diptera (1).

752. Telephium Tourn.

2420. T. Imperati L. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 173, 213, 308.)—At the beginning of anthesis, the stigmas occupy the middle of the flower and are close together, while the anthers are mature, and present their pollen to visitors. Subsequently, when the stigmas have become receptive and diverge, autogamy is prevented, for the concave petals, which previously spread out like a star, come together and cover the anthers, so that only cross-pollination is possible.

753. Scleranthus L.

Literature.—Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 73.

Flowers inconspicuous, apetalous, whitish or greenish; homogamous, protogynous or protandrous; with half-concealed nectar secreted by the thickened bases of the sepals, and a ring at the base of the ovary.

2421. S. annuus L. (Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 73; Schulz, 'Beiträge,' I, p. 39, II, p. 76.)—The green flowers of this species are homogamous. At first the stamens are pressed against the bell-shaped calyx, so that at this stage cross-pollination may be effected by insect-visits. The stamens subsequently become erect, so that anthers and stigmas are brought into contact, and automatic self-pollination consequently takes place. The amount of nectar secreted in the base of the flower is very limited. These are the facts I observed on the island of Amrum. Schulz at Halle also noticed slight protandry, as well as gynodioecism and gynomonoecism (5–10 %), rarely andromonoecism and androdioecism. The same writer

states that cleistogamous (according to Hansgirg pseudo-cleistogamous) flowers are borne in winter under the snow.

Visitors.—MacLeod (Flanders) observed a Muscid (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 172). Plateau (Flanders) noticed Diptera and a bee (Prosopis sp.).

2422. S. perennis L. (Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 73; Herm. Müller, 'Fertilisation,' p. 509, 'Weit. Beob.,' II, p. 224; Schulz, 'Beiträge,' II, pp. 75–6; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The broad white-edged sepals are expanded at the time when the flower possesses mature reproductive organs, so that the flowers are much more conspicuous than those of S. annuus, which are always bell-shaped. Moreover, a much larger quantity of nectar is secreted in their bases. The stamens at first lie upon the expanded sepals, while the styles with the simultaneously mature stigmas project from the centre. Afterwards the sepals gradually close, and the anthers are brought into contact with the stigmas: automatic self-pollination follows if cross-pollination has not been effected by insects in the first stage of anthesis. These are the facts observed by me in the island of Amrum.

Hermann Müller gives a similar account of the flower mechanism in plants growing at Lippstadt. Schulz observed at Halle that the style of the hermaphrodite flowers varies greatly in length—between $\frac{3}{4}$ mm. and $2\frac{1}{2}$ mm. The short-styled form is homogamous or slightly protandrous, and automatic self-pollination is possible; the long-styled form on the other hand is often distinctly protandrous, and therefore crossing is effected. The number of stamens is also subject to variation, and so is the size of the flower. Warnstorf describes the pollen-grains as yellow in colour, tuberculate, on an average 35 μ in diameter.

Visitors.—The following were observed by the authorities, and for the localities stated.—

MacLeod (Pyrenees), a Chrysididid and 4 flies (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 381). Plateau (Belgium), nect-lkg. ants. Schulz, numerous flies and ants. Herm. Müller.—**A. Diptera.** *Muscidae*: 1. Miltogramma intricata *Mg.*, skg. **B. Hymenoptera.** *Vespidae*: 2. Holopyga coriacea *Dahlb.*, nect-lkg. **C. Lepidoptera.** *Rhopalocera*: 3. Coenonympha pamphilus *L.*, skg. Verhoeff (Norderney).—**A. Diptera.** (*a*) *Muscidae*: 1. Anthomyia sp., skg.; 2. Aricia incana *Wiedem.* ♀, do.; 3. Cynomyia mortuorum *L.* ♂, do.; 4. Sarcophaga striata *F.* ♀, do.; 5. Sepsis cynipsea *L.* (*b*) *Stratiomyidae*: 6. Chrysomyia formosa *Scop.* ♂, skg. (*c*) *Syrphidae*: 7. Eristalis arbustorum *L.* ♀ and ♂, skg.; 8. Platycheirus sp. **B. Hymenoptera.** *Formicidae*: 9. Lasius niger *L.* ☿, skg.

LXXXVI. ORDER *AMARANTACEAE* JUSS.

754. Amaranthus L.

2423. A. Blitum L. (= Albersia Blitum *Kunth*). (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—Warnstorf says that the flowers of this species are protogynous and anemophilous. The female flowers are much more numerous than the male. The stigmatic papillae are three-celled and clavate. The pollen-grains are pale yellowish in colour, irregularly polyhedral, tuberculate, on an average 25 μ in diameter.

2424. A. retroflexus L.—Warnstorf (op. cit.) says that the small, greenish, diclinous (monoecious) flowers of this species are anemophilous. Male flowers occur among the more numerous female ones. The latter possess three stigmas beset with very large papillae. The anthers are greenish, and borne on delicate flaccid filaments. The pollen-grains are whitish in colour, irregularly spheroidal, with numerous germinating papillae, 31–3 μ in diameter.

Visitors.—Plateau noticed a fly (Musca domestica *L.*) and a beetle (Cassida nobilis *L.*).

LXXXVII. ORDER *CHENOPODIACEAE* VENT.

Literature.—Sprengel, 'Entd. Geh.,' p. 7; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 126; Volkens in Engler and Prantl, 'D. nat. Pflanzenfam.,' III, 1 a, p. 47; Kirchner, Jahreshefte Ver. Natk., Stuttgart, xlix, 1893, p. 109.

Flowers belonging to species of this order are hermaphrodite, or dioecious by reduction. They possess a small, insignificant, calyx-like perianth, or are sometimes quite naked. Insect-visits are therefore very rare, and the flowers are generally anemophilous or self-pollinated.

Sprengel describes Chenopodium and Beta as anemophilous. Volkens considers that they are entomophilous: 'First of all, I think that wind-pollination can at any rate only be of secondary importance. There are three reasons for this: first, the pollen is not easily dispersable; secondly, the order does not possess the slender, limp, supple filaments, flower-stalks, or inflorescence-axes which are peculiar to anemophilous flowers; and thirdly, the course of anthesis does not agree with that of other anemophilous flowers, in which not only all the flowers open more or less simultaneously, but the anthers dehisce almost all at once. Nothing like this occurred in the plants of the order which I examined. If a plant belonging to Chenopodium or Atriplex be observed towards autumn, it will be at once seen that of the hundreds and perhaps thousands of flowers covering the stock, only a very few are completely open. Anthesis goes on in this way for weeks, but the further maturation of the ovaries usually takes place extraordinarily quickly; thus towards the end of the vegetative period there is scarcely any time at which all stages of the flower, from bud to fruit, may not be found simultaneously on the same plant.

'Also the flower itself does not open suddenly. Following the course of the spiral, one perianth leaf after another spreads out, together with the stamen opposed to it, the anther of which dehisces at the same moment and sheds its pollen. If the facts quoted are against the theory of wind-fertilization, that of insect pollination is favoured by the great attraction which at least our native species undoubtedly exert upon various kinds of insects. Scarcely a plant of any species growing in the open air is to be found in Germany, the flowers of which are not infested by an excessive number of small bugs, aphides, flies, and other little animals which creep or crawl. Whether these are merely attracted by the excellent hiding-places which the crowded fasciculate inflorescences afford, or whether the glandular disk, particularly in species of Beta and Chenopodium, or the papillae covering this organ in many Salsoleae provide food for them, I must leave undecided.'

Kirchner agrees with these observations of Volkens, though without extending the assumption of entomophily to all species of the order. He also observed a slight secretion of nectar in the bases of flowers belonging to Chenopodium album *L.* growing in sunny places. There is a fair amount of nectar in Chenopodium Vulvaria *L.*

755. Suaeda Forsk.

Flowers hermaphrodite and devoid of nectar.

2425. S. maritima Dumort. (= Chenopodina maritima *Moq.*, and Chenopodium maritimum *L.*). (Warming, 'Ekskursioner'; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 126.)—The flowers of this species are homogamous or feebly protandrous. Automatic self-pollination is easily possible.

756. Salsola L.

As Suaeda.

2426. S. Kali L. (Kirchner, Jahreshefte Ver. Natk., Stuttgart, xlix, 1893, p. 110; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 126, 'Bl. u. Insekt. a. Helgoland,' p. 32.)—This species is homogamous or protogynous. Automatic self-pollination is possible. Kirchner says that the stigma projects from the flower bud. In Helgoland I found the flower homogamous, but the stigma, which is strongly papillose all the way round at the top, though only on the inner surface lower down, is still receptive after the anthers have dehisced. The latter project beyond the stigma, automatic self-pollination being therefore possible by the fall of pollen. Although the five filaments are stiff, the pollen is easily dispersed, being very fine. The plant is therefore predominantly anemophilous, though occasional insect-visits are not excluded.

Kirchner also considers this species entomophilous. He describes the two filiform stigmas as projecting from the flower bud, and the perianth as only opening to set the quickly elongating stamens free, when the anthers are shrivelled. The white filaments are erect, and the yellow pollen scattered by the anthers (which are of the same colour) is not powdery, but clings somewhat together. Secretion of nectar could not be observed. Occasionally the anthers dehisce before the stigmas are shrivelled, in which case automatic self-pollination is possible.

Warnstorf describes the pollen-grains as sulphur-yellow in colour, rounded polyhedral, their surface divided into regular pentagonal and hexagonal areas, separated by depressions, and 25–31 μ in diameter.

Visitors.—Plateau observed po-dvg. hover-flies (Eristalis arbustorum *L.*, and Syritta pipiens *L.*).

2427. S. Soda L.—The flowers of this species are pale green in colour.

Visitors.—Plateau observed a hover-fly (Syritta pipiens *L.*) and minute Muscids.

2428. S. crassa Bieb.—

Visitors.—Plateau observed Syritta pipiens *L.*, and other po-dvg. hover-flies.

757. Salicornia L.

Flowers hermaphrodite and devoid of nectar.

2429. S. herbacea L. (Warming, 'Ekskursioner'; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 126; Schulz, 'Beiträge,' I, p. 93.)—Schulz says that the flowers of this species are feebly protogynous, but possess persistent stigmas, so that in consequence of the proximity of the anthers automatic self-pollination is easily possible.

758. Kochia Roth.

As the preceding species. Gynomonoecious.

2430. K. scoparia Schrad. (Kirchner, loc. cit.)—Kirchner says that this species may be considered anemophilous if the scattered distribution of the very inconspicuous flowers and the structure of stigma and pollen are taken into account. They are gynomonoeciously distributed, small female ones growing in the leaf-axils on the lower part of the stem and branches, usually in pairs, and the larger hermaphrodite ones on the upper ends of the branches. All flowers have a green, five-leaved perianth, and two long, white, filiform stigmas, thickly beset with lateral hairs, project from the female ones. The hermaphrodite flowers are strongly protogynous, their two stigmas, of the same structure as those of the female ones, being fully mature before the perianth opens. After they have shrivelled, the stamens elongate, at first forcing the perianth leaves apart; later on, however, when the anthers are situated above the perianth leaves, the stamens grow between them, permitting them once more to apply themselves to the ovary; one after another the red anthers now dehisce successively by means of two longitudinal slits. The filaments are stiff and directed obliquely upwards, all the yellow, powdery pollen falling out of the dehisced anthers in a little cloud when the plant is shaken.

This species is anemophilous. Gynomonoeciously distributed female flowers may be found in addition to the markedly protogynous hermaphrodite ones.

2431. K. hirsuta Nolte (= Echinopsilon hirsutus *Moq.*, and Salsola hirsuta *L.*). (Warming, 'Ekskursioner'; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins,' p. 126.)—As the preceding species. The flowers are homogamous or protogynous, and automatic self-pollination is possible.

759. Chenopodium L.

FIG. 349. *Chenopodium ambrosioides*, *L.* (after F. Hildebrand). The flower is upright, and the anthers project beyond the stigmas, thus rendering autogamy possible.

Usually markedly protogynous, rarely homogamous (C. ambrosioides *L.* being the only case). Pollen-flowers; inconspicuous and almost always devoid of nectar, receiving therefore only occasional insect-visits and being generally fertilized by means of the wind, although neither the flowers nor the stamens are easily movable. Sometimes andromonoecious or androdioecious.

2432. C. ambrosioides L. (Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.,' p. 62.)—The flowers of this species are homogamous. The anthers are situated above the stigmas, automatic self-pollination being thus easily effected by fall of pollen.

2433. C. Botrys L. (Kirchner, 'Beiträge,' p. 13.)—The flowers of this, and of the three following species, are markedly protogynous. The receptive stigmas project from the bud before it is mature. When these are shrivelled the five anthers ripen in succession, each perianth leaf diverging as the stamen opposed to it matures. When the stamens fade, the perianth leaves once more apply themselves to the ovary.

2434. C. hybridum L. (Kirchner, op. cit., pp. 13–14.)—The flower mechanism of this species resembles that of C. Botrys, but the perianth has finished growing when the mature stigmas project from it. When these have shrivelled and dropped off, the stamens elongate one after another, the corresponding perianth leaves diverging at the same time. When the whole perianth has thus expanded, it closes again after all the stamens have shrivelled.

2435. C. album L. (Herm. Müller, 'Weit. Beob.,' II, p. 221; MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, pp. 376–8; Kirchner, 'Flora v. Stuttgart,' p. 221, Jahreshefte Ver. Natk., Stuttgart, xlix, 1893, p. 109, 'Neue Beob.,' p. 16.)—The inconspicuous, odourless flowers of this species are markedly protogynous, though sometimes homogamous. The three, more rarely two, filiform stigmas are receptive almost before the flower has reached half its full size. The perianth leaves leave a small opening at the top, through which they can protrude. The five stamens are scarcely perceptible even in rudiment during this time, for they only mature and project from the flower (the perianth-leaves expanding at the same time), after the stigmas have shrivelled. The anthers then dehisce, and the perianth closes again, so that the filaments are held fast between its lobes. Flowers in the most various stages of anthesis are associated in the same fascicle. Sometimes one of the five stamens is reduced, in which case the corresponding perianth leaf does not expand, but remains applied to the ovary. Kirchner observed one plant which secreted nectar.

Visitors.—Buddeberg (Nassau) observed a Muscid (Anthomyia sp.), po-dvg.

2436. C. polyspermum L. (Kirchner, 'Neue Beob.,' p. 17, 'Flora v. Stuttgart,' p. 223.)—The flower mechanism of this species resembles that of C. album. In the first (female) stage the two stigmas project from between the tips of the perianth leaves, which completely enclose the ovary. When they have faded, the three stamens mature in succession, the corresponding perianth leaves bending outwards at the same time. The two perianth leaves having no stamens opposed to them do not become reflexed, but remain apposed to the ovary.

2437. C. murale L. (Kirchner, 'Neue Beob.,' p. 17, 'Flora v. Stuttgart,' p. 222; Schulz, 'Beiträge,' I, pp. 93–4.)—The mechanism of this species agrees entirely with that of C. album except that the two stigmas are very short, and (according to Schulz) so short-lived that they are often faded before the flower opens.

2438. C. glaucum L. (Kirchner, 'Flora v. Stuttgart,' p. 222; Schulz, 'Beiträge,' I.)—The mechanism of this species resembles that of C. album, but the rather short stamens mature, as in C. polyspermum, as soon as the equally short stigmas have shrivelled. Schulz observed andromonoecious (up to 50 %), and rarely androdioecious flowers.

2439. C. rubrum L. (Schulz, 'Beiträge,' I.)—This species is also markedly

protogynous, the stigmas being shrivelled when the anthers dehisce. Schulz occasionally observed purely male plants.

2440. C. Bonus-Henricus L. (Warming, Bot. Tids., Kjöbenhavn, ii, 1877; Kirchner, 'Neue Beob.,' p. 17, 'Flora v. Stuttgart,' pp. 223–4.)—Warming has already shown that this species is protogynous, in which it agrees with most allied forms. Again the two or three (rarely four) rather long stigmas first mature, the stamens ripening only after these have faded; the filaments are no longer than the perianth leaves, which diverge very little. The individual flowers of a spike mature fairly simultaneously, so that adjacent ones are in about the same stage of anthesis.

2441. C. Vulvaria L. (Kirchner, Jahreshefte Ver. Natk., Stuttgart, xlix, 1893, p. 107; Schulz, 'Beiträge,' II, p. 198.)—Kirchner states that the hermaphrodite flowers of this species are markedly protogynous, and that there are also male flowers distributed singly among them, reaching (according to Schulz) to as much as 50 %. Purely male stocks are rare. Kirchner observed secretion of nectar in this species as in C. album. Hildebrand ('D. Geschlechts-Vert. b. d. Pfl.,' p. 62) says that the hermaphrodite flowers are homogamous, so that they seem to vary between homogamy and protogyny.

2442. C. ficifolium Sm.—Kirchner describes this species as markedly protogynous.

2443. C. urbicum L.—This species is also said by Kirchner to be strongly protogynous.

760. Blitum L.

Kirchner says that the flower mechanism of species belonging to this genus agrees with that of Chenopodium. Their flowers are therefore entomophilous.

2444. B. virgatum L.—

Visitors.—Kirchner observed Physopods.

2445. B. capitatum L. (= Chenopodium capitatum *Aschers.*).—

Visitors.—Kirchner observed aphides.

761. Beta L.

Flowers hermaphrodite.

2446. B. maritima L. (= B. vulgaris *L.*, according to the *Index Kewensis*).—MacLeod, who examined this species in Jersey, describes the small green flowers as strongly protandrous, so that self-pollination is excluded. The ovary is surrounded by a nectar-secreting ring bearing the short stamens.

Visitors.—MacLeod observed several small flies, Ichneumonids, and short-tongued bees. Plateau noticed bees (Prosopis sp., and Andrena sp.).

2447. B. vulgaris L. (Herm. Müller, 'Weit. Beob.,' II, p. 221.)—

Visitors.—Buddeberg (Nassau) observed the hover-fly Melanostoma mellina *L.*, po-dvg.

762. Atriplex L.

Monoecious. Geitonogamy is rendered possible by the crowded inflorescences. Volkens (Engler and Prantl, 'D. nat. Pflanzenfam.,' III, 1 a) says that the flowers

are adapted for insect pollination, as anthesis lasts for weeks, giving ample opportunity for insect-visits.

2448. A. littoralis L. (Knuth, 'Bl. u. Insekt. a. d. Halligen.')—This species is probably anemophilous, but occasionally pollinated by means of insects. Volkens (op. cit.) is of opinion that species of Atriplex are entomophilous, because anthesis extends over several weeks. My observations showed insect-visits to be extremely few, as might be expected from the inconspicuousness of the flowers.

Visitors.—Knuth (Kiel Harbour) observed the hover-fly Syrphus balteatus *Deg.*, po-dvg.

2449. A. hastata L. (Knuth, op. cit.)—This species agrees with A. littoralis.

2450. A. portulacoides L. (= Obione portulacoides *Moq.*). (Knuth, op. cit.) —This species is perhaps anemophilous.

2451. A. pedunculata L. (= Obione pedunculata *Moq.*).—As the last species.

LXXXVIII. ORDER *POLYGONACEAE* JUSS.

Literature.—Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 127, 'Grundriss d. Blütenbiol.,' p. 88.

Flowers generally hermaphrodite, possessing a petaloid perianth that serves to attract insects. Their crowding into spicate or paniculate inflorescences increases their conspicuousness. The number and frequency of visits is proportionate to the size of these and the amount of nectar secreted. The probability of cross-pollination increases accordingly and the importance of automatic self-pollination is lessened. Many species are dimorphous.

763. Rumex L.

Flowers hermaphrodite, dioecious, or polygamous; protandrous, homogamous, or protogynous; anemophilous, but receiving occasional insect-visits. Filaments and flower-stalk generally flexible. Stigma penicillate. Geitonogamy is possible, the flowers being usually arranged in dense panicles.

Haussknecht asserts that hybridization by means of the wind may be easily effected in consequence of the close association of different species.

Hermann Müller observed in the Alps that the fiery-red fruits of Rumex species frequently attracted butterflies (sp. of Polyommatus and Argynnis) of similar colour, which settled on them for a considerable time ('Alpenblumen,' p. 182).

2452. R. crispus L. (Axell, 'Om Anord. för Fanerog. Växt. Befrukt.,' p. 57; Schulz, 'Beiträge,' II, p. 155; Kirchner, 'Flora v. Stuttgart,' p. 209.)—This species bears protandrous wind flowers, sometimes gynomonoecious or androdioecious; the female are smaller than the hermaphrodite ones. Schulz says that the stigmatic branches of the latter are hidden between the leaves of the perianth when the anthers dehisce, so that in consequence of the pendulous position of the flower autogamy is prevented. When the anthers have dropped off, the three stigmatic branches project freely. The female flowers contain vestiges of six stamens. Occasionally some of the stamens are reduced in the hermaphrodite flowers.

Warnstorf (Verh. bot. Ver., Berlin, xxxviii, 1896) says that three forms of the species occur near Ruppin :—

(1) With larger, homogamous hermaphrodite flowers, in which the stigmas do not project from between the perianth leaves.

(2) With smaller female flowers, among which are found hermaphrodite ones.

(3) With very small, purely female flowers, in which the stigmas project far beyond the perianth leaves.

The pollen-grains are white in colour, smooth, rounded-tetrahedral, 37·5 to 44 μ in diameter.

2453. R. obtusifolius L. (Tulberg, Bot. Not., Lund, 1868, p. 12; Herm. Müller, 'Fertilisation,' p. 516, 'Weit. Beob.,' II, p. 222; Kirchner, 'Flora v. Stuttgart,' p. 210; Schulz, 'Beiträge'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, 295, 298. 315.)—Kirchner says that the flower mechanism of this species agrees with that of the preceding one. Tulberg describes the flowers as markedly protandrous; the stigma is not accessible until after the falling of the stamens, when it is rendered so by the bending back of the perianth leaves—which have hitherto covered it. Kerner states, on the contrary, that the plant is protogynous. Schulz observed gynomonoecism and androdioecism. Warnstorf describes the pollen-grains as white in colour, irregularly polyhedral, tuberculate, up to 44 μ in diameter.

Visitors.—Herm. Müller observed the bee Halictus cylindricus *F.* ♀ on the anthers.

2454. R. sanguineus L. (Schulz, 'Beiträge,' I, p. 95.)—Schulz describes this species as feebly protandrous, Kerner as protogynous. Schulz observed andromonoecious and androdioecious as well as hermaphrodite flowers. Automatic self-pollination is not possible in the hermaphrodite ones, as pollen cannot easily reach the stigma. Numerous flowers remain unfertilized because the perianth remains closed and the stigmas are therefore hidden.

2455. R. conglomeratus Murr. (Schulz, loc. cit.)—The comparatively small stigmas of the hermaphrodite flowers of this species usually mature at the same time as the anthers, sometimes a little later, rarely before them. The relative position of the reproductive organs and their homogamy render automatic self-pollination inevitable. Schulz observed andromonoecious as well as hermaphrodite flowers. He says that this species is not anemophilous, as the flowers are not pendulous on flexible stalks.

2456. R. maritimus L. (= R. aureus Mill.). (Schulz, op. cit., I, p. 94.)—The flowers of this species are homogamous. Each of the inner perianth leaves possesses two tooth-like processes on its lowest third, on which the stigmas lie while the flower is still in the bud. When anthesis begins, the stigmas are situated immediately below the anthers, and as both organs mature simultaneously, automatic self-pollination is inevitable. Pollen is seldom removed from the flower, as the anthers project only a little or not at all beyond the perianth, and the stalks are not pendulous or flexible, but either horizontal or erect. Schulz denies the existence of anemophily. The flowers are sometimes gynomonoecious or androdioecious.

2457. R. pulcher L. (Schulz, op. cit., II, pp. 153–4.)—The perianth of flowers belonging to this species remains almost closed, the anthers projecting only

a little or not at all beyond it, and the stigmas being situated beneath them: automatic self-pollination is therefore inevitable, and, in fact, the only possible means of fertilization, for towards the end of dehiscence the perianth leaves generally close tightly round the anthers again. The flowers are sometimes gynomonoecious and androdioecious.

2458. R. alpinus L. (Schulz, op. cit., II, p. 154; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, 143, 295, 298, 312.)—In this species the anthers first dehisce. During this stage the three stigmas mature, and finally project so far beyond the flower that they are easily dusted with pollen from younger blossoms. This is facilitated by the fact that during dehiscence the flower stalks are flexible, and the flowers therefore easily swayed by the wind. After dehiscence, however, the stalks become rather stiff, so that during the female stage the flowers are only slightly movable.

The flowers are sometimes gynomonoecious and andromonoecious. Female ones are generally considerably smaller than those which are hermaphrodite or male.

Kerner states that in this species, as in R. sanguineus and R. obtusifolius, the female and male flowers predominate in the inflorescences, with only a few hermaphrodite ones. The stigmas are receptive some time before the anthers of flowers on the same stock have dehisced. Crossing by means of wind must therefore be effected. Geitonogamy is also possible, for though the stigmas of the hermaphrodite flowers are at first hidden, they are exposed by the bending back of the perianth lobes and pollen from adjacent younger blossoms can fall on them.

2459. R. longifolius H. B. et K. (= R. domesticus *Hartm.*). Ekstam says that this species possesses first protogynous, then homogamous hermaphrodite flowers, which are pollinated by wind: they are sometimes gynomonoecious.

2460. R. scutatus L. (Schulz, op. cit., II, pp. 154–5.)—The hermaphrodite flowers of this species are markedly protandrous. The stigmas generally remain unreceptive until after the anthers have dehisced, thus apparently excluding self-pollination. Anemophily is, however, easily effected, for the large, brush-shaped stigmas are well exposed to currents of air. Gynomonoecism and androdioecism sometimes occur.

2461. R. Acetosella L. (H. Hoffmann, Bot. Ztg., Leipzig, xliii, 1885; MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 140; Schulz, op. cit., II, p. 198.)—Lindman states that the hermaphrodite flowers of this species on the Dovrefjeld are first protogynous, then homogamous; and that gynomonoecious as well as hermaphrodite flowers occur there. Schulz says that the flowers are usually dioecious, with both sexes equally numerous, much more rarely gynomonoecious or hermaphrodite.

Appel tells me in a letter that he observed purely male stocks.

2462. R. Acetosa L. (Schulz, op. cit., II, p. 198; Knuth, 'Beiträge.')—As the preceding species.

Visitors.—Knuth (Glücksburg, 30. 7. '96) observed numerous honey-bees, eagerly skg., and flying steadily from flower to flower, their entire bodies grey with pollen.

2463. R. montanus Desf. (= R. arifolius *All.*). (Schulz, op. cit., II, p. 198.)—

This species is, like the two preceding ones, generally dioecious (with both sexes in about equal numbers), much more rarely gynomonoecious, andromonoecious, or hermaphrodite.

764. Rheum L.

Flowers entomophilous, with half-concealed nectar.

2464. R. Rhaponticum L. (Axell, 'Om Anord. för Fanerog. Växt. Befrukt.,' p. 57; Knuth, 'Beiträge,' I.)—

Visitors.—Knuth saw hover-flies (Syrphus sp.), po-dvg., on garden specimens.

2465. R. undulatum L. (?). (Herm. Müller, 'Weit. Beob.,' II, pp. 222–3.)—The crowded, greenish-yellow flowers of this species are tolerably conspicuous. They secrete a small quantity of nectar from the receptacle, between the roots of the filaments, and are markedly protandrous. The stigmas do not mature until the anthers have withered, so that self-pollination is excluded. Insect-visits at least effect geitonogamy.

Visitors.—Loew (Berlin Botanic Garden) saw the po-dvg. beetle Cetonia aurata *L.*, and Herm. Müller gives the following list for Westphalia.—

A. Coleoptera. (*a*) *Curculionidae*: 1. Spermophagus cardui *Stev.* (*b*) *Dermestidae*: 2. Anthrenus muscorum *L.* **B. Diptera.** (*a*) *Empidae*: 3. Empis sp., skg. (*b*) *Muscidae*: 4. Anthomyia, various sps. (*c*) *Syrphidae*: 5. Ascia podagrica *F.*, freq.; 6. Cheilosia sp.; 7. Eristalis nemorum *L.*; 8. Helophilus floreus *L.*; 9. Syritta pipiens *L.*, freq.

2466. R. hybridum Murr.—

Visitors.—Loew (Berlin Botanic Garden) saw the Elaterid beetle Lacon murinus *L.*, dvg. the anthers.

2467. R. tataricum L. (?).—

Visitors.—Plateau observed the following po-dvg. beetles.—

1. Cantharis fusca *L.*; 2. Phyllopertha horticola *L.*; 3. Trichius abdominalis *Mén.*; 4. Anthrenus sp., freq.

765. Oxyria Hill.

Hermaphrodite or gynomonoecious wind flowers.

2468. O. digyna Hill (= Rumex digynus *L.*). (Lindman, 'Bidrag till Känned. om Skandin. Fjellväxt. Blomn. o. Befrukt., p. 36; Schulz, 'Beiträge,' II, p. 199; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. v.)—Schulz and Kerner in the Tyrol, and Lindman on the Dovrefjeld, found this species to be gynomonoecious. Lindman says that the hermaphrodite flowers are first protogynous and then homogamous; Ekstam makes a similar statement for Nova Zemlia. Andersson and Hesselman describe the species as blooming in Spitzbergen from the second half of June till the end of July; the fruit beginning to ripen from the beginning of August ('Bidrag till Känned. om Spetsbergens o. Beeren Eil. Kärlväxtflora,' p. 66). Ekstam states that in Spitzbergen the flowers are feebly protogynous or protogynous-homogynous ('Blütenbiol. Beob. a. Spitzbergen,' pp. 29–30).

766. Polygonum L.

Literature.—Herm. Müller, 'Fertilisation,' p. 516; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 127–8; Meehan, Proc. Acad. Nat. Sci., Philadelphia (Pa.), (1889) 1890.

Flowers mostly homogamous or protandrous, belonging to classes **Po**, **EC**, and **C**. Perianth generally petaloid, and flowers frequently aggregated into conspicuous inflorescences. Nectar either secreted in the base of the flower or absent. Sometimes dimorphism. Gynodioecism or gynomonoecism frequent. Meehan says that numerous species, e.g. P. Persicaria *L.*, P. aviculare *L.*, and P. Hydropiper *L.*, bear cleistogamous flowers.

Hermann Müller states that 'The species of Polygonum, like those of Geranium, show clearly how with conspicuousness and abundance of honey the number and variety of visitors increase, and how, as the likelihood of cross-fertilization is thus increased, the possibility of self-fertilization becomes less important; the converse is also clear. But they show at the same time that the abundance of a plant is in no way determined alone by the certainty of cross-fertilization' (op. cit., p. 516).

2469. P. Fagopyrum L. (= Fagopyrum esculentum *Moench*). (Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.,' p. 40; Jordan, K. F., Ber. D. bot. Ges., Berlin, v,

Fig. 350. *Polygonum Fagopyrum*, *L.* (after Herm. Müller). (1) Long-styled, and (2) short-styled flower, after removal of two perianth leaves. *a*, anthers; *n*, nectary; *st*, stigmas.

1887; Herm. Müller, 'Fertilisation,' pp. 509, 516; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 129, 166–7; Kirchner, 'Flora v. Stuttgart,' p. 213; Schulz, 'Beiträge,' II.)—The flowers of this species are dimorphous, with exposed to half-concealed nectar. They are white or reddish in colour, and crowded together so as to be highly conspicuous; in consequence of this, their honey-like odour, and great richness in nectar, insect-visits are extremely numerous. Cross-pollination by means of heterostyly is therefore ensured, while automatic self-pollination is only occasionally possible.

The diameter of the flower is about 5 mm. Eight (sometimes nine) large yellow nectaries, bound together by a cushion-like swelling, are situated at the base of the ovary: their abundant secretion always attracts swarms of insects.

The long stamens and pistils are fully 3 mm. long, the shorter ones almost 2 mm. In the long-styled form, therefore, the widely exserted stigmas project 2 or 3 mm. beyond the anthers; in the short-styled form they are about the level of the middle of the filaments. The pollen-grains of the latter form are larger than

those of the long-styled one. These two forms (at any rate in the island of Föhr) apparently do not grow together; long-styled flowers are to be found in one part of a field and short-styled ones in another.

Jordan says that three of the eight stamens surround the style, the anthers turning their pollen-covered surfaces outwards; the other five bend further outwards, their pollen-covered surfaces facing inwards. Insects probing for nectar are therefore dusted with pollen on each side of their bodies, visitors to the long-styled flowers usually brushing the anthers with their heads, and those to the short-styled ones with the thorax. As the stigmas and anthers at the same level naturally come into contact with corresponding parts of the insects' bodies, legitimate union is usually effected. Illegitimate union and automatic self-pollination are, however, also easily possible, but less effective.

Schulz states that gynomonoecious, rarely gynodioecious, occasionally andromonoecious, and very rarely androdioecious flowers also occur.

Jordan says that three stamens turn the pollen-covered surfaces of their anthers outwards, while the remaining five, which curve more towards the perianth leaves, turn them inwards, so that insects probing for nectar are dusted on both sides of their bodies.

Visitors.—Herm. Müller gives the following list.—

A. Diptera. (*a*) *Muscidae*: 1. Lucilia cornicina *F.*, skg.; 2. Musca corvina *F.*, do.; 3. Pollenia vespillo *F.*, do.; 4. Sarcophaga carnaria *L.*, do. (*b*) *Stratiomyidae*: 5. Odontomyia viridula *F.*, do.; 6. Stratiomys chamaeleon *Deg.*, freq.; 7. S. riparia *Mg.*, skg. (*c*) *Syrphidae*: 8. Cheilosia scutellata *Fall.*, skg. and po-dvg.; 9. Chrysotoxum festivum *L.*, do.; 10. Eristalis arbustorum *L.*, do.; 11. E. intricarius *L.*, do.; 12. E. nemorum *L.*, do.; 13. E. pertinax *Scop.*; 14. E. sepulcralis *L.*, do.; 15. E. tenax *L.*, do.; 16. Helophilus floreus *L.*, do.; 17. Melithreptus scriptus *L.*, do.; 18. Pipiza funebris *Mg.*, do.; 19. Syritta pipiens *L.*, do.; 20. Syrphus pyrastri *L.*, do. **B. Hymenoptera.** (*a*) *Apidae*: 21. Apis mellifica *L.* ☿, extremely numerous (making up nine-tenths of the visitors), skg. and po-cltg.; 22. Andrena albicrus *K.* ♀, skg.; 23. A. bicolor *F.* (= A. aestiva *Sm.*) ♂, do.; 24. A. dorsata *K.* ♀, do.; 25. A. fulvicrus *K.* ♂ and ♀, freq., skg. and po-cltg.; 26. A. helvola *L.* ♀, skg.; 27. A. nana *K.*, do.; 28. A. pilipes *F.* ♀, do.; 29. A. varians *K.* ♀, do.; 30. Bombus lapidarius *L.* ♀ and ☿, skg.; 31. Sphecodes gibbus *L.*, do. (*b*) *Sphegidae*: 32. Cerceris labiata *F.* ♀, do.; 33. C. nasuta *Dahlb.* (= C. quinquefasciata *Ross.*) ♂, skg.; 34. Pompilus trivialis *Klg.*, do. (*c*) *Tenthredinidae*: 35. Athalia spinarum *F.*, skg. **C. Lepidoptera.** All skg.: 36. Pieris brassicae *L.*; 37. P. napi *L.*; 38. Polyommatus phlaeas *L.*; 39. Vanessa urticae *L.*

The following were recorded by the observers, and for the localities stated.—

Schletterer (Pola), the Scoliid Scolia hirta *Schr.* MacLeod (Flanders), the honey-bee, 2 short-tongued bees, a saw-fly, 7 hover-flies, 5 Muscids, 3 Lepidoptera, and a beetle (Bot. Jaarb. Dodonaea, Ghent, vi, 1895, p. 142).

2470. P. tataricum L. (= Fagopyrum tataricum *Gaertn.*).—Schulz describes the green flowers of this species as homogamous, and sometimes gynomonoecious and gynodioecious.

2471. P. perfoliatum L. (Hildebrand, Bot. Centralbl., Cassel, Beih. xiii, 1902, pp. 335–8.)—This climbing East Indian species produces fleshy fruits of turquoise colour. Hildebrand states that plants cultivated in the Freiburg Botanic Garden bore nothing but completely cleistogamous flowers for seven successive years.

2472. P. Bistorta L. (Ricca, Atti Soc. ital. sc. nat., Milano, xiv, 1871, p. 3; Herm. Müller, 'Fertilisation,' pp. 511, 516, 'Weit. Beob.,' II, p. 221, 'Alpenblumen,' p. 179; Schulz, 'Beiträge,' I, p. 95; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 327; Knuth, 'Bloemenbiol. Bijdragen.')—The flowers of this species belong to class **C**. They are bright reddish-white in colour, and aggregated into a dense spike, being thus made so conspicuous that insect-visits are very numerous. Cross-pollination is ensured by strong protandry, and automatic self-pollination excluded.

Hermann Müller states that nectar is secreted by eight fleshy, reddish glands situated at the bases of the stamens, and stored at the bottom of the perianth-tube. At first only the stamens project from the slightly open flower, the styles remaining immature until the stamens have fallen, so that the stigmas then project about as far beyond the perianth as the anthers did previously.

Schulz says that in the Riesengebirge and the Alps, but rarely in the lowlands, gynodioeciously, rarely gynomonoeciously, distributed female flowers occur (usually only up to 5 %), as well as protandrous hermaphrodite ones. In the Riesengebirge he also observed flowers with shorter stamens in addition to the form described above, in which they project beyond the perianth.

FIG. 351. *Polygonum Bistorta*, L. (after Herm. Müller). (1) Flower in the first (male) stage. (2) Do., in the second (female) stage.

Kerner describes the spicate inflorescence as consisting of small cymes, made up of two, or rarely three, flowers, of which one is long-styled and hermaphrodite, and the other male, with reduced style. In each of the cymes thus constituted the hermaphrodite flower opens first, anthesis beginning at the bottom and proceeding upwards. Later on all the male flowers open in the same way, and scatter their pollen on the still receptive stigmas of adjacent hermaphrodite ones.

Ludwig (D. bot. Monatsschr., Arnstadt, vi, 1888) states that small, pale, quite immature buds are to be found on a young inflorescence together with the red flower-buds, and these do not unfold until the anthesis of the primary flowers is quite over. He distinguishes between the following stages:—

(1) Male stage of the primary flowers, four of the stamens ripening first and the other four afterwards.

(2) Female stage of the first generation. The anthers have dropped off and the stigmatic branches are divergent. The flowers close, and their colour becomes brighter. Those of the second generation have not yet opened, but their pedicels have elongated.

(3) The stalks of the first generation, now setting fruits, are situated close to the axis. Those of the second generation have elongated to such an extent that they project far beyond those of the former. This is the male stage of the second, generally paler generation.

(4) Female stage of the second generation. Still other flowers frequently mature.

Warnstorf describes the pollen-grains as white in colour, gleaming like crystals, ellipsoidal-prismatic, smooth, about 37 μ broad and 63 μ long.

Visitors.—Herm. Müller (Alps) observed a beetle, 10 Diptera, 5 Hymenoptera, and 22 Lepidoptera. He gives the following list for Westphalia.—

A. Coleoptera. (*a*) *Coccinellidae*: 1. Coccinella quattuordecimpunctata *L.* (*b*) *Scarabaeidae*: 2. Trichius fasciatus *L.*, dvg. the flowers (Vosges Mts.) (*c*) *Telephoridae*: 3. Malachius bipustulatus *L.*, dvg. the anthers. (*d*) *Nitidulidae*: 4. Meligethes sp. **B. Diptera.** (*a*) *Bibionidae*: 5. Bibio hortulanus *L.* (*b*) *Empidae*: 6. Empis livida *L.*, skg. (*c*) *Muscidae*: 7. Sarcophaga carnaria *L.* (*d*) *Syrphidae*: 8. Ascia podagrica *F.*, po-dvg.; 9. Eristalis arbustorum *L.*, skg. methodically; 10. Rhingia rostrata *L.*, do.; 11. Syritta pipiens *L.*, po-dvg., and skg. with less method; 12. Syrphus ribesii *L.* **C. Hymenoptera.** (*a*) *Apidae*: 13. Andrena albicans *Müll.* ♀; 14. Apis mellifica *L.* ☿; 15. Prosopis signata *Pz.* ♂, obtaining no booty. (*b*) *Sphegidae*: 16. Cerceris variabilis *Schr.* as 15; 17. Oxybelus uniglumis *L.*, do. (*c*) *Tenthredinidae*: 18. Tenthredo sp., trying to suck (Vosges Mts.). **D. Lepidoptera.** *Rhopalocera*: 19. Botys purpuralis *L.*, skg.; 20. Pieris brassicae *L.*, do.

Loew noticed the following.—

Silesia ('Beiträge,' p. 51).—**A. Coleoptera.** (*a*) *Cerambycidae*: 1. Leptura virens *L.*; 2. Pachyta clathrata *F.*; 3. Strangalia melanura *L.* (*b*) *Chrysomelidae*: 4. Clytra diversipes *Letz.* (*c*) *Staphylinidae*: 5. Anthophagus spectabilis *Heer.* **B. Hymenoptera.** *Sphegidae*: 6. Crabro quadrimaculatus *F.* ♀ and ♂. **C. Lepidoptera.** *Noctuidae*: 7. Agrotis conflua *Tr.* Switzerland (op. cit., p. 66).—**Diptera.** (*a*) *Empidae*: 1. Rhamphomyia anthracina *Mg.* (*b*) *Muscidae*: 2. Cyrtoneura podagrica *Lw.*; 3. C. simplex *Lw.* (*c*) *Syrphidae*: 4. Eristalis rupium *F.* Berlin Botanic Garden. Flies (Anthomyia sp.), skg.

The following were recorded by the observers, and for the localities stated.—

Ludwig—Empids. Frey (Switzerland), a butterfly (Polyommatus hippothoë *L.*) and a moth (Agrotis ocellina *S.-V.*): (Upper Engadine), the Noctuid moth Mithymna imbecilla *M.* Koch (Seiser Alp in the South Tyrol)—a Muscid (Loxocera elongata *Mg.*), a Stratiomyid (Odontomyia personata *Lw.*), and a Syrphid (Eristalis intricarius *L.*). MacLeod (Pyrenees), a saw-fly, an Empid and a Muscid (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 374): (Flanders), a humble-bee, another bee (Halictus sp.), a hover-fly (Syritta sp.), an Empid (Empis sp.), a Muscid, a beetle, and a Lepidopterid (op. cit., vi, 1894, p. 376). Scott-Elliott (Dumfriesshire), a saw-fly, an Empid, and 2 other flies ('Flora of Dumfriesshire,' p. 149).

2473. P. viviparum L. (Axell, 'Om Anord. för Fanerog. Växt. Befrukt.,' p. 27; Ricca, 'Atti Soc. ital. sc. nat.,' Milano, xiv, 1871; Herm. Müller, 'Fertilisation,' p. 512, 'Alpenblumen,' pp. 180–2; Schulz, 'Beiträge'; Warming, 'Bestövningsmaade,' pp. 31–3.)—The flowers of this species belong to class **C.** The length and course of anthesis of stamens and styles vary greatly in different districts. Axell observed purely female stocks in Swabia in addition to hermaphrodite, markedly protandrous ones. In the Alps Hermann Müller found partly hermaphrodite (but homogamous), and partly purely female stocks. Schulz also observed there gynodioecism, more rarely gynomonoecism, and androdioecism with homogamous hermaphrodite flowers. Lindman describes the plants of the Dovrefjeld as gynodioecious and gynomonoecious, with homogamous flowers. In Greenland Warming found

hermaphrodite and purely female stocks, the former with styles and stamens of varying length. Ekstam describes the plants of the Swedish highlands as being also homogamous.

In spite of not infrequent insect-visits and the facilities for automatic self-pollination in the hermaphrodite flowers, fruits are but rarely set. The plant propagates, in fact, almost always vegetatively by means of bulbils. Ekstam says that the feebly odorous flowers in Nova Zemlia are protogynous-homogamous. Most of them are modified into bulbils. According to Lindman, the flowers on the Dovrefjeld are partly hermaphrodite, partly (and more often) female with vestigial anthers. In Nova Zemlia hermaphrodite flowers are much more numerous than the female ones. Andersson and Hesselman state that the species flowers in Spitzbergen from the beginning of July to the middle of August; ripe fruits were not observed, but bulbils were thrown off from the middle of August ('Bidrag till Känned. om Spetsbergens o. Beeren Eil. Kärlväxtflora,' p. 65). Ekstam describes the flowers in Spitzbergen as white to red-violet or red in colour, protogynous-homogamous, 2–4 mm. in diameter, and slightly fragrant ('Blütenbiol. Beob. a. Spitzbergen').

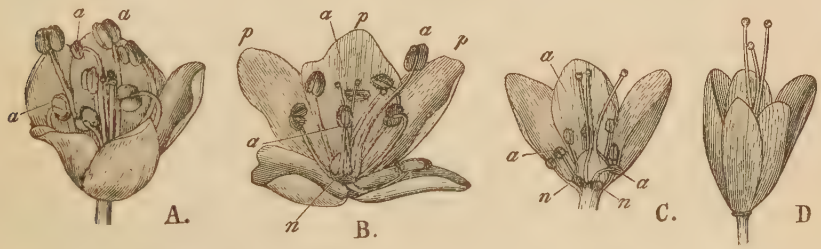


FIG. 352. *Polygonum viviparum*, *L.* (after Herm. Müller). *A*. Hermaphrodite flower. *B*. Do., with the part forcibly separated. *C*. Female flower, after removal of the anterior perianth leaves. *D*. Female flower with still longer styles (× 7). *a*, inner anthers; *n*, nectary; *p*, upper perianth leaves.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), an Empid, a Syrphid, 2 bees, 10 Lepidoptera, and a beetle. Schulz (Alps), flies, bees, and Lepidoptera. Lindman (Alps), medium-sized flies. Loew (Switzerland), the Empid Empis tessellata ('Beiträge,' p. 60). Schneider (arctic Norway), 7 humble-bees—1. Bombus lapponicus *F.* ☿ and ♂; 2. B. nivalis *Dahlb.* ☿; 3. B. pratorum *L.* ☿ and ♂; 4. B. scrimshiranus *K.* ☿ and ♂; 5. B. terrester *L.* ☿ and ♂; 6. Psithyrus quadricolor *Lep.* ♂; 7. P. vestalis *Fourcr.* ♂ (Mus. Aarsh., Tromsø, xvii, 1895). Ekstam (Spitzbergen), none.

2474. P. amphibium L. (Kirchner, 'Flora v. Stuttgart,' p. 216; Schulz, 'Beiträge,' II; Knuth, 'Weit. Beob. ü. Bl. u. Insekt, a. d. nordfr. Ins.')—The flowers of this species belong to class **C**. They are pink to purple-red in colour, smell like honey, and are dimorphous. Nectar is secreted at the base of the ovary by five orange-yellow glands, and hidden in the bottom of the perianth, which is about 5 mm. long. In the short-styled form this opens in the shape of a funnel, and so widely, that an entrance of about 4 mm. broad is formed, in which the two globular stigmas are situated, the five anthers projecting $1\frac{1}{2}$–2 mm. beyond them. In the long-styled form the perianth leaves close up until a much narrower entrance is left, through

which the two styles project about 1½ mm., while the two anthers are situated about a mm. below the mouth of the flower.

Schulz observed gynomonoecism or gynodioecism occurring frequently or sometimes even exclusively.

The terrestrial form (var. *terrestre* Leers) possesses short hairs on the stalks, which secrete a viscid fluid serving as a protection against creeping insects; the aquatic form (var. *natans* Moench) is glabrous, the surrounding water giving access to none but flying insects.

Visitors.—Knuth (Föhr) observed the following.—

A. Diptera. (*a*) *Muscidae*: all po-dvg.: 1. Aricia incana *Wied.* ♂; 2. Coenosia tigrina *F.* ♀; 3. Lucilia sp.; 4. Scatophaga merdaria *F.*; 5. S. sp. (*b*) *Syrphidae*: 6. Eristalis sp., po-dvg. **B. Hymenoptera.** *Apidae*: 7. Apis mellifica *L.* ☿, po-cltg. and skg.; 8. Halictus cylindricus *F.* ♀, po-cltg. **C. Lepidoptera.** *Rhopalocera*: 9. Coenonympha pamphilus *L.*, skg.

The following were recorded by the observers and for the localities stated.—

MacLeod (Flanders), the hover-fly Eristalis tenax *L.* (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 375). Scott-Elliot (Dumfriesshire), a Muscid, a hover-fly, and several Dolichopodids ('Flora of Dumfriesshire,' p. 149).

2475. P. Persicaria L. (Herm. Müller, 'Fertilisation,' p. 512; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 128, 166; Verhoeff, 'Bl. u. Insekt. a. d. Ins. Norderney'; Schulz, 'Beiträge'; Kirchner, 'Flora v. Stuttgart,' pp. 216–17.)—The flowers of this species belong to classes **C** to **EC.** They are small, odourless, white or reddish in colour, rather poor in nectar, and united into crowded inflorescences; a certain conspicuousness is thus attained, and insect-visits are fairly frequent; cross-pollination is therefore possible, though automatic self-pollination often takes place. There is a nectary at the base of each of the eight stamens, but the secretion is scanty. Three stamens are usually reduced or entirely absent; but not infrequently flowers occur with six, seven, or eight fully developed ones. The two (more rarely three) stigmas mature simultaneously with the anthers, and are at the same level. At first the perianth leaves and the five fertile stamens alternating with them bend so far outwards that the stigmas are not touched. When more than five stamens mature they bend towards the middle and bring about automatic self-pollination by coming into contact with the stigmas. But even in flowers in which only five stamens mature, automatic self-pollination takes place later, and this is effective, as almost all flowers set fruits.

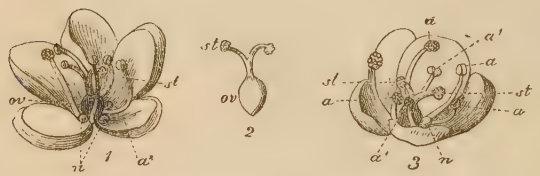


Fig. 353. *Polygonum Persicaria*, *L.* (after Herm. Müller). (1) A flower with five stamens. (2) Pistil. (3) A flower with seven stamens. *a* and *a'*, outer and inner stamens; a^2, vestigial stamen; *n*, nectary; *ov*, ovary; *st*, stigmas.

When visited by insects, the flowers may be self- or cross-pollinated with equal facility, as they are so small that the insect's head, on entering, must touch stigmas and anthers at the same time. Should the insect insert its head only once, cross-pollination is effected, but repeated entrances bring about self-pollination.

Visitors.—Herm. Müller gives the following list for Westphalia.—

A. Diptera. *Syrphidae*: 1. Ascia podagrica *F.*, very common; 2. Eristalis arbustorum *L.*, skg. and po-dvg.; 3. E. sepulcralis *L.*, comparatively freq.; 4. E. tenax *L.*, freq.; 5. Melithreptus scriptus *L.*, skg. and po-dvg.; 6. M. taeniatus *Mg.*, do.; 7. Syritta pipiens *L.*, the commonest visitors. **B. Hymenoptera.** *Apidae*: 8. Andrena dorsata *K.* ♀, occasional, skg.; 9. Halictus albipes *F.* ♀, do.; 10. Prosopis armillata *Nyl.* ♂, do. **C. Lepidoptera.** *Rhopalocera*: 11. Pieris rapae *L.*, casual, skg.

The following were recorded by the observers, and for the localities stated.—

Knuth (Holstein and Rügen), the honey-bee and the hover-fly Syritta pipiens *L.* Verhoeff (Norderney), the moth Plusia gamma *L.* Alfken (Juist), the humble-bee Bombus hortorum *L.* ♀, and the butterfly Pieris brassicae *L.* MacLeod (Flanders), the honey-bee and 2 hover-flies (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 145). Scott-Elliot (Dumfriesshire), 2 Muscids ('Flora of Dumfriesshire,' p. 149).

2476. P. lapathifolium L. (Herm. Müller, 'Fertilisation,' p. 314; Schulz, 'Beiträge,' II, p. 199; MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 145.)—The homogamous flowers of this species belong to classes **C** to **EC**. Their mechanism agrees entirely with that of P. Persicaria. Five stamens are generally present, one or more of them not infrequently coming into contact with the stigmas as they bend inwards.

Visitors.—Herm. Müller observed 3 hover-flies, skg.—1. Ascia podagrica *F.*; 2. Eristalis sepulcralis *L.*; 3. Syritta pipiens *L.*

2477. P. Hydropiper L. (Kirchner, 'Flora v. Stuttgart,' p. 218; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 391; Schulz, 'Beiträge,' II, p. 199.)—The small, inconspicuous flowers of this species are green outside with pink tips; Kirchner says that they are devoid of nectar, the nectaries being completely reduced. Two of the eight stamens are generally vestigial; the anthers of the other six are of the same height as the stigma, so that when both organs mature simultaneously, automatic self-pollination is regularly effected. Kerner states that in some flowers the perianth remains closed under certain circumstances, and pseudo-cleistogamous fertilization takes place.

Schulz observed occasional gynomonoecious flowers.

2478. P. mite Schrank (= P. laxiflorum *Weihe*). (Kirchner, 'Flora v. Stuttgart,' p. 218; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, 391.)—The homogamous flowers of this species are a little more conspicuous than those of the preceding one, for they are somewhat larger and only green at the base, the upper part being pink-red or white in colour. Kirchner states that there is a nectary at the base of each of the five to eight stamens. The flowers open very little, and the anthers are situated slightly above the stigmas (which mature at the same time), so that automatic self-pollination is inevitable. Kerner says that pseudo-cleistogamous fertilization sometimes takes place in this species.

Fig. 354. *Polygonum minus*, *Huds.* (after Herm. Müller). (1) Flower seen obliquely from above. (2) Do., after removal of the two front perianth leaves; seen from the side. *a* and *a'*, outer and inner stamens; *n*, nectaries; *st*, stigmas.

2479. P. minus L. (Herm. Müller, 'Fertilisation,' p. 514; MacLeod, Bot.

Jaarb. Dodonaea, Ghent, vi, 1894, p. 144; Kirchner, 'Flora v. Stuttgart,' p. 216; Verhoeff, 'Bl. u. Insekt. a. d. Ins. Norderney'; Knuth, 'Beiträge.')—The flower mechanism agrees with that of the preceding species; there are, however, usually six to eight, more rarely five stamens, which are of about the same height as the three stigmas, and mature simultaneously with the anthers. The flowers are small and pink, or more rarely white, in colour. There may be pseudo-cleistogamy as in P. mite.

Visitors.—Herm. Müller observed 4 hover-flies—1. Ascia podagrica *F.*, skg.; 2. Melithreptus menthastri *L.*, skg. and po-dvg.; 3. M. pictus *Mg.*, do.; 4. Syritta pipiens *L.*, skg.

2480. P. aviculare L. (Herm. Müller, 'Fertilisation,' p. 515; MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 144; Kirchner, 'Flora v. Stuttgart,' p. 216; Verhoeff, 'Bl. u. Insekt. a. d. Ins. Norderney'; Knuth, 'Beiträge.')—The flowers of this species are very small (scarcely $2\frac{1}{2}$ mm. in diameter), and green in colour, with purple-red or white edges. As they are devoid of nectar and odourless, and situated singly in the leaf-axils, they possess very little power of attraction and very rarely receive insect-visits; they are, in fact, almost limited to automatic self-pollination, which is very effective, as almost all flowers set fruits. The perianth leaves diverge widely. The five stamens that alternate with them bend outwards, while the three others bend inwards, so that they are brought just above the two stigmas, which mature simultaneously with them. Automatic self-pollination is therefore inevitable by fall of pollen. When the flowers are visited by insects either self- or cross-pollination may be effected with equal facility. Although the filaments possess a fleshy thickening at the base, no secretion of nectar is to be found, the flowers offering only pollen to visitors. Hermann Müller observed, however, that Syritta pipiens not only devoured pollen, but inserted its proboscis into the base of the flower: it either sought nectar in vain or licked off a shallow layer.

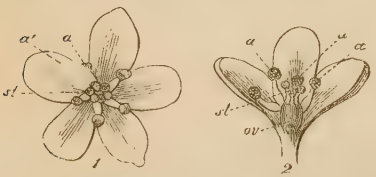


Fig. 355. *Polygonum aviculare*, *L.* (after Herm. Müller). (1) Flower seen from above. (2) Do., after removal of the two front perianth leaves and half the stamens; seen from the side. *a* and *a'*, inner and outer stamens; *ov*, ovary; *st*, stigmas.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Verhoeff (Norderney), the hover-fly Syrphus corollae *F.* Knuth (Kiel), the hover-fly Syrphus balteatus *Deg.*, po-dvg. Herm. Müller (Westphalia), 3 hover-flies—1. Ascia podagrica *F.*, po-dvg.; 2. Melithreptus menthastri *L.*, do.; 3. Syritta pipiens *L.*, and perhaps also skg.

2481. P. Convolvulus L. (Kirchner, 'Flora v. Stuttgart,' p. 212; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 166.)—The flowers of this species belong to classes **C** to **EC**. Although they are situated in fascicles in the leaf-axils, they receive few insect-visits on account of their small size and the inconspicuousness of the green, white-edged perianth. Kirchner says, therefore, that they are almost entirely restricted to automatic self-pollination. Anthers and stigmas mature simultaneously; but the flowers at first open so widely that these organs do not come into contact. Gradually,

however, the stamens bend so far inwards that the anthers (three of which sometimes remain closed, while the others dehisce inwards) dust the stigmas with pollen. Nectar is secreted in small quantities at the base of the stamens. Kerner observed pit-like nectaries on the leaf-stalks.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel, on a hot afternoon after prolonged rain), 2 bees—Apis mellifica *L.* ☿, freq., skg., and Halictus flavipes *F.* ♀, occasional, skg., with an equal chance of self- and cross-pollination. MacLeod (Flanders), a hover-fly (Syritta sp.), Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 146.

2482. P. dumetorum L. (Kirchner, 'Flora v. Stuttgart,' p. 214.)—The green, homogamous flowers of this species are situated in fascicles in the leaf-axils, and expand in the sunshine. Their mechanism agrees with that of the preceding species, the eight stamens bending first outwards and then inwards, so that the eight anthers can automatically pollinate the stigmas, which mature simultaneously with them and stand at the same level.

2483. P. cuspidatum Sieb. et Zucc. (Knuth, 'Blütenbiol. Notizen.')—The odourless flowers of this species are aggregated into large, crowded racemes, and therefore very conspicuous.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel Oberrealschule Garden, 11. 9. '97), large numbers of the following Muscids, skg.—1. Anthomyia sp.; 2. Calliphora erythrocephala *Mg.*; 3. C. vomitoria *L.*; 4. Lucilia caesar *L.*; 5. L. cornicina *F.*; 6. Musca cervina *F.*; 7. M. domestica *L.*; 8. Sarcophaga carnaria *L.*; 9. Scatophaga stercoraria *L.* Loew (Berlin Botanic Garden), 2 Muscids—Graphomyia maculata *Scop.*, and Lucilia caesar *L.*

767. Koenigia L.

2484. K. islandica L.—The flowers of this species belong to class **C.** Axell states that they possess three comparatively large, swollen, yellow nectaries alternating with the three stamens. Self-pollination takes place as a rule in consequence of the simultaneous maturation, equal length, and proximity of anthers and stigma. Andersson and Hesselman state that the species flowers on Spitzbergen from mid-July to mid-August ('Bidrag till Känned. om Spetsbergens o. Beeren Eil. Kärlväxtflora,' p. 66).

768. Emex Neck.

2485. E. spinosa Campd. (S. Murbeck, 'Ü. einige amphikarp. nordwestafrik. Pfl.,' Vet.-Ak. Öfvers., Stockholm, lviii, 1901–2; Bot. Centralbl., Cassel, xci, 1903, p. 26.)—Murbeck states that the South European and North African species bears unisexual flowers, the female ones being partly subterranean. These are larger than the aerial form, and possess a fleshy spongy perianth, and elongated stigmas which project above the surface.

LXXXIX. ORDER *CYTINACEAE* BROGN.

769. Brugmansia Blume.

2486. B. Zippelii Blume.—

Visitors.—Delpino says ('Ult. oss.') that this species is pollinated by flesh-flies, which are kept prisoners for some time in the flowers. Darwin, on the other hand, considers that the pollinators are long-beaked humming-birds, while short-beaked ones steal nectar by perforation.

770. Rafflesia R. Br.

2487. R. Arnoldi R. Br.; **2488. R. Horsfieldii** R. Br.; and **2489. R. Patma** Blume.—

Visitors.—Delpino supposes ('Ult. oss.') that these species are pollinated by carrion-flies.

XC. ORDER *ARISTOLOCHIACEAE* JUSS.

771. Aristolochia Tourn.

Species of this genus bear protogynous pitfall-flowers, usually secreting a little nectar (perhaps by the edges of the trap).

2490. A. clematitis L. (Sprengel, 'Entd. Geh.,' pp. 418–29; Hildebrand, Jahrb. wiss. Bot., Leipzig, v, 1874; Delpino, 'Ult. oss.,' pp. 228–9; Herm. Müller, 'Fertilisation,' p. 517; Correns, Jahrb. wiss. Bot., Leipzig, xxii, 1891, pp. 161–89, Bot. Centralbl., Cassel, lii, 1892, pp. 439–43.)—Sprengel discovered the working of the flower mechanism in this species by his acute investigations, overlooking only the protogyny of the flowers and their consequent cross-pollination, which characteristics were subsequently found out by Hildebrand. Correns turned his attention to the anatomy and physiology of the hairs which close the entrance to the pitfall.

The flower is bright yellow, the middle part of its perianth forming a tube, which widens below into a globular trap, and is produced above into a tolerably flat limb. When this last unfolds the flower is upright, and the tube is beset with downwardly-directed hairs on the inner side, which allow tiny insects (flies and gnats) to enter, but prevent them from creeping out again. During this stage the stigma is receptive, but the six gynandrous anthers are still unripe. In the vain attempt to find nectar or obtain their freedom once more, the insects, if they have brought pollen from another flower, will dust the stigma with it, and effect cross-pollination. The anthers then dehisce, and the hitherto upright flower-stalk begins at the same time to bend downwards, while the hairs closing the flower-entrance shrivel, so that the exit is no longer barred to the little prisoners. Completely covered with pollen, they emerge and transfer it to a flower in the first stage. Finally the limb of the perianth drops so far down that the tube of the flower (now completely reversed in position) is completely closed, and no longer accessible to insects.

Corren says that the weel-hairs temporarily closing the entrance to the trap grow more and more thickly as they approach it, but scarcely increase in size. He also

states that three parts may be distinguished in them—the base, the joint, and the hair proper. The root of each hair is situated in a shallow depression of the perianth and its basal cell is thick-walled. The joint, by means of which the hair bends, is formed by one very thin-walled cell. The strength necessary for bearing the hair is supplied by the hydrostatic pressure, which Corren showed to reach not less than 22 atmospheres. The hair itself consists of several thin-walled, plate-like cells. In this case also the needful firmness is due to a high degree of turgidity (up to 15 atmospheres). The hair, which in its normal position is directed obliquely downwards against the pit, is depressed still further by a small insect forcing its way in, and enabling it to pass on. The hair then springs back into its original position. An insect is prevented from creeping out again by a barrier (observed by Hildebrand), formed by a knob on the base of the hair, which is directed upwards and impinges against the wall of the perianth. This barrier, however, is an imperfect one, for the knob only touches the perianth at one point, so that an oblique pressure can force the hair against the wall, the joint-cell undergoing torsion. The chief obstacle to an insect's escape is to be found in the fact that the weel-hairs are considerably longer than half the width of the perianth tube. They therefore usually cling together in front of the barrier, so as to render escape impossible.

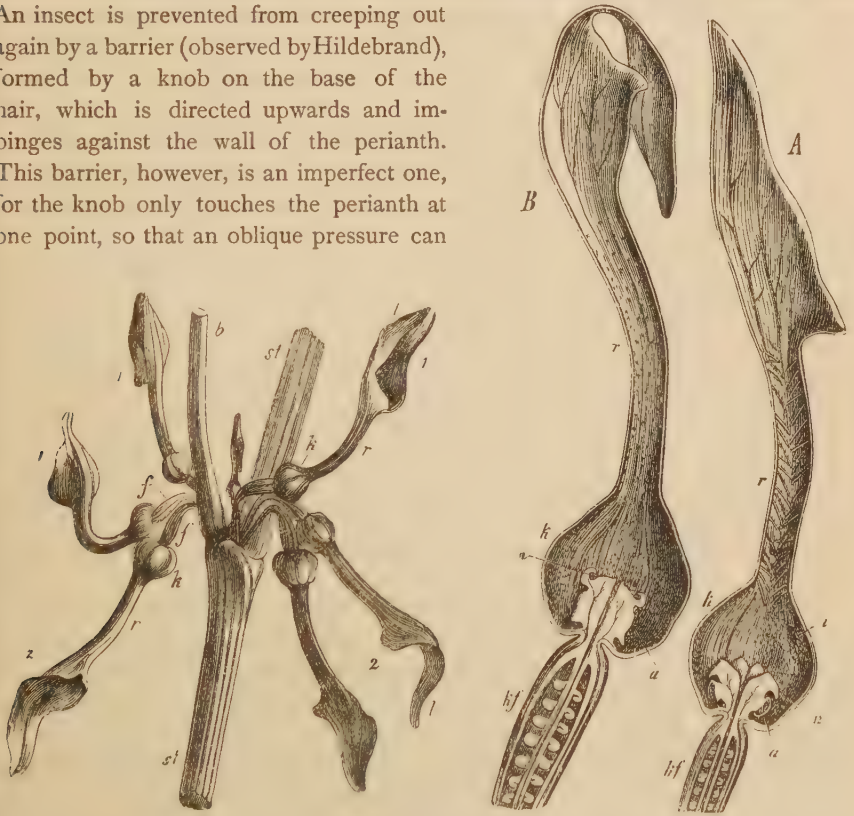


FIG. 356. *Aristolochia Clematitis*, *L.* (after Sachs). A piece of stem (*st*), with a petiole (*b*), in the axil of which a number of flowers are situated. 1, Young still unfertilized flowers; 2, fertilized do., directed downwards (natural size). *A* and *B*. Flowers before and after pollination, in section (enlarged). *a*, anthers; *f*, inferior ovary; *k*, trap; *kf*, ovary in section; *l* (in left-hand figure), limb of perianth, (in *A*) a trapped insect; *n*, stigma; *r*, perianth tube.

Correns (op. cit., p. 169 footnote) says that Sprengel's figure is better than the one from Sachs here given, for it represents the hairs in the trap as minute prickles, and the weel-hairs as withered at the beginning of the second stage.

When the weel-hairs have finished their work, they shrivel into short brown vestiges. This is only possible because the cell-walls have not been thickened, for considerable thickening would impart the same firmness as turgidity, and such thick-walled cells could not be displaced later on after they had faded. The hairs, however, though very thin-walled, are sufficiently stiffened by the high turgidity already mentioned. This makes it possible later on for them to shorten like a concertina, so that their insignificant remains present no further hindrance to the creeping out of insects. Such shrivelling results from the death of old hairs, and begins at the apex, working downwards; it is not affected either by the taking place or the failure of pollination.

The trap is also lined with hairs, which chiefly grow between the six main veins, three denser bands alternating with three thinner ones. In the second stage of anthesis these trap-hairs frequently stick together and hang down in large tufts, these again adhering together at their tips. Correns consequently supposes that nectar is secreted, even though but scantily. Possibly the few stomata on the inside of the trap (especially round the gynostemium) are connected with this supposed secretion. The trap-hairs do not wither with the weel-hairs, but elongate appreciably when the second flower stage begins.

Visitors.—Sprengel long ago observed numerous minute flies; Correns says, however, that in spite of abundant insect-visits fruits are seldom set.

Sprengel (and subsequently Hildebrand) discovered that flies carry away pollen from the flowers on their backs. Correns considers that this goes to prove that they crawl about the wall of the trap rather than over the gynostemium.

The following were recorded by the observers stated.—

Herm. Müller, 3 Diptera (species determined by Winnertz)—(*a*) *Bibionidae*: 1. Scatopse soluta *Loew* (= S. inermis *Ruthe*). (*b*) *Chironomidae*: 2. Ceratopogon sp.; 3. Chironomus sp. Delpino ('Ult. oss.'), 4 Diptera—1. Oscinis dubia *Macq.*: 2. Ceratopogon lucorum *Mg.*; 3. C. aristolochiae *Rond.*; 4. Campylomyza lucorum *Rond.*

Kny ('Bot. Wandtafeln') states that the species is adapted by its entire flower mechanism for cross-pollination by small flies (particularly Ceratopogon pennicornis *Zett.*). If not visited by cross-pollinators, however, autogamy is not excluded, for the pollen-grains germinate and send out long pollen-tubes that reach the stigma of the same flower.

2491. A. Sipho L'Hérit. (Hildebrand, op. cit.; Delpino, op. cit.; Herm. Müller, op. cit.; Correns, op. cit.)—This ornamental species is indigenous to North America. During anthesis the flower, which is shaped like the bowl of a pipe, is first directed downwards, and then vertically upwards. The flower mechanism agrees with that of the preceding species, and the plant is visited by the same insects. The tube leading to the trap, however, possesses no barrier hairs, and it is not clear at first why the small visitors are detained until the anthers have dehisced. Delpino and Hildebrand think that the inner surface of the perianth is at first so slippery that the insects cannot creep up it—this only becoming possible when the wall begins to shrivel towards the end of anthesis, and is no longer so smooth. Hermann Müller justly remarks.—

'This explanation can only be correct if that part of the tube which slopes

downwards from the entrance is distinctly smoother than the other portion which leads up from the lowest part of the tube to the expanded terminal chamber; for, if both are equally smooth the flies will have as much difficulty in climbing up into the stigmatic chamber as in climbing back out of the flower. In Arum I have repeatedly noticed that the small midges try to escape from their prison, not by creeping, but by flying towards the light, and get knocked down by the grating at the mouth of the flower. So if in *Aristolochia Sipho* the inside of the tube is all so smooth that flies can climb neither one way or the other from the lowest part, the reason of their imprisonment must be sought only in the curvature of the two ends of the tube, the one rising straight from the lowest part to the cage, while the other part which rises up towards the entrance to the flower is so bent outwards at its upper end that the insects flying towards the light knock against the end and fall back again. They are set free by the shrivelling up of the corolla, which enables them to creep out.' ('Fertilisation,' p. 518.)

Hermann Müller's opinion is rendered much more probable by observation I made upon Arisarum vulgare in Capri. This plant is distinguished from species of the genus Arum in the same way that Aristolochia Sipho differs from A. Clematitis, i. e. by the absence of weel-hairs. In Arisarum I saw numerous tiny gnats and flies which had crept into the flower trying to escape, and constantly striking against the window-like, transparent stripes of the spathe, in their efforts to do so. Only a few exhausted ones, which crept slowly to the top of the spadix, were able to get out. This barrier, which is partly dependent for success on the stupidity of the flies, is so good, that the plant may be carried about for some time without the escape of a single insect; when the spathe is cut open, however, they fly away immediately. This takes place similarly in Aristolochia Sipho.

Correns declares these hypotheses regarding the detention of flies in the flowers to be insufficient, and thinks that it is scarcely possible to form a decision in Europe, but only by observation of the plant in its North American home. He also says that the narrow part of the perianth tube possesses no proper weel-hairs, but closely packed, downwardly directed papillae, which are perhaps connected with the insects' lengthened stay in the trap. The latter falls in two parts, the glabrous 'antechamber,' and the trap proper, the lower two-thirds of which are of a black-purple colour, and lined with white hairs. The 'trap-hairs' are mixed with other hook-like 'twining-hairs'; these easily break to pieces from the apex downwards as the flower grows old, splitting through the sexta either into single cells or pairs of cells. Correns definitely proved secretion of nectar by fixing the flower upside down for a few hours.

W. Burck is of opinion (Ann. Jard. bot., Buitenzorg, viii, 1890) that flowers belonging to species of Aristolochia are adapted for self-pollination; but Correns considers Burck's entire arguments against cross-pollination as partly actually mistaken, and partly insufficiently substantiated. Burck overlooked the fact that the species examined by him in Java were of American origin, and that plants which in their native countries are adapted for cross-pollination, in other regions frequently become autogamous, autocarpous, or even cleistogamous in consequence of the lack of pollinating insects. E. Ule (Die Natur, Halle, xlvii, 1898, pp. 207, 210) thoroughly examined some Brazilian species of Aristolochia (A. macroura, A. brasiliensis,

A. elegans) at Rio de Janeiro, and found that the fly visitors, some of which are imprisoned, effectually pollinate the stigma.

Visitors.—The following flies were recorded by the observers stated.—

Herm. Müller—(*a*) *Muscidae*: 1. Myodina vibrans *L.*; 2. Sapromyza apicalis *Loew*, very freq. (*b*) *Phoridae*: 3. Phora pumila *Mg.* Delpino ('Ult. oss.')—1. Phora nigra *Mg.*; 2. P. pumila *Mg.*; 3. Ceratopogon aristolochiae *Rond.*; 4. Lonchaea tarsata *Fall.*

2492. A. altissima Desf. (Delpino, 'Ult. oss.,' p. 28.)—The flower mechanism of this species deviates but little from that of A. Clematitis.

Visitors.—Delpino observed 3 flies (determined by Rondani)—1. Ceratopogon lucorum *Mg.*; 2. Phora pumila *Mg.*; 3. P. pulicaria *Fall.*

2493. A. rotunda L. and **2494. A. pallida** Willd. (Delpino, loc. cit.)—The flower mechanisms of these species differ but little from that of A. Clematitis. The joint-cell of the weel-hairs is thin-walled on its under-side, but generally thickened above, and provided with a thin porous spot just in front of the septum dividing it from the foot-cell. Correns thinks this may be a protection against fracture as the result of pressure. Correns describes the flowers of A. pallida as larger than those of A. Clematitis. They always grow singly and quite upright; their perianth is green in colour, with a crescentic brown-black patch opposite the excavated side. Five or six streaks of the same colour reach from this down the funnel-shaped tube into the short, cylindrical trap. This is beset with long hairs, which stick together later on. The tube is lined with weel-hairs resembling those of A. Clematitis. An imperfect closure of the perianth tube takes place towards the end of anthesis by the bending down of its lip.

Visitors.—Delpino ('Ult. oss.') observed 3 flies (determined by Rondani) in the flowers of A. pallida—1. Phora carbonaria *Lett.*; 2. P. pulicaria *Fall.*); 3. Chironomus gracilis *Macq.* (?).

The flowers of A. rotunda also grow singly and always upright. The green perianth possesses a narrow, cylindrical tube, which ends in a comparatively large, flat limb, brown-black on its inner side. After the anthers have dehisced, it bends sharply backwards and downwards, folds up round the perianth tube, and so closes the flower entrance completely. The weel-hairs situated in the perianth tube resemble those of A. Clematitis, but the barrier apparatus is more perfect. Both A. rotunda and A. pallida possess abundant 'twining-hairs' on the outer wall of the perianth and on the ovary. These consist of a basal cell (sometimes subdivided), one or two intermediate cells (neck-cells), and one reflexed hook-cell, which lies parallel with the perianth wall (the opening of the hook directed upwards).

Visitors.—Delpino observed 7 flies (determined by Rondani) in A. rotunda.—1. Scatopse nigra *Mg.*; 2. Ceratopogon minutus *Mg.*; 3. Sciara minima *Mg.*; 4. Cecidomyia atricapilla *Rond.*; 5. Oscinis aristolochiae *Rond.*; 6. O. delpinii *Rond.*; 7. O. dubia *Macq.*

2495. A. fimbriata Cham. (= A. Bonplandi *Tenore*).—Hildebrand says (Bot. Ztg., Leipzig, xxviii, 1870, p. 603) that this species agrees with A. Sipho in the shape of its perianth, and with A. Clematitis in the arrangement of the weel-hairs.

2496. A. Ruiziana Duch. (= A. Duchartrei *André*); and **2497. A. elegans** Mast.—These two species are tropical. Correns says (op. cit.) that there are two areas in the pit which are more thickly covered with hairs than the rest, and may be considered as nectaries. As the weel-hairs are only one-third as long as the lumen of the perianth tube, the barrier apparatus is formed by two projections. The hair thus touches the perianth wall at two separate points, one to the right and the other to the left of the joint, and is therefore able to resist lateral impact.

2498. A. grandiflora Sw. (Delpino, op. cit.)—This species is indigenous to the Antilles, and is distinguished by its wine-red colour and smell of carrion, which facts give rise to the supposition that the very large flowers are visited by carrion-flies. A tendril proceeding from the perianth limb winds round an adjacent branch to hold the flower in the right position for insect visitors.

772. Asarum L.

The blossoms of species belonging to this genus are protogynous and not very conspicuous; Hermann Müller describes them as nauseous flowers (Kosmos, Leipzig, iii, 1878). He considers that they perhaps act as prisons or at least as hiding-places for insect visitors, and so form a stage leading up to the mechanism of Aristolochia (*cf.* Vol. i, p. 128).

2499. A. europaeum L. (Delpino, 'Altri appar. dicog. recent. oss.,' pp. 61–2; Herm. Müller, 'Fertilisation,' p. 517, Kosmos, Leipzig, iii, 1878; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 279; Kirchner, 'Flora v. Stuttgart,' p. 520; Knuth, 'Bloemenbiol. Bijdragen.')—The flowers of this species grow singly close to the ground often hidden by fallen leaves. They are of a greenish-brown colour outside and dirty-red brown inside, not very conspicuous, and possessing a sharp, camphor-like odour. The three perianth lobes open slowly, in such a way that their tips remain for some time curved inwards, while they spread out below. Three small cleft-like entrances to the interior of the flower are thus formed, behind which the already mature stigmas are situated, so that they must be touched by insects on entering. Kerner says the visitors are small flies. The hexamerously arranged stigmatic lobes bear (according to Kirchner) tufts of stigmatic papillae facing outwards. In the first stage of anthesis the twelve stamens, arranged in two whorls, are

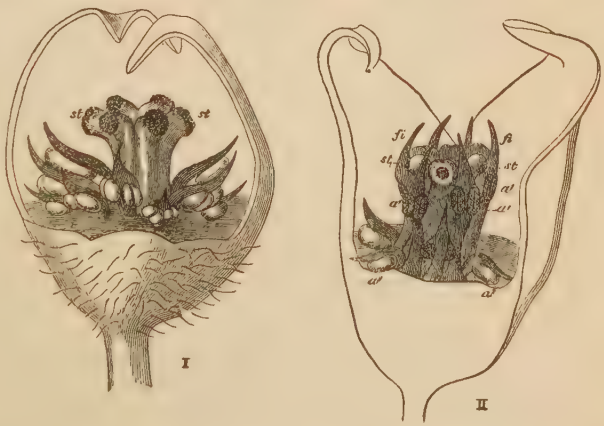


FIG. 357. *Asarum europaeum*, *L.* (after Herm. Müller). . Young flower, just opening; half the perianth removed. *II.* Older flower; the most anterior short stamens are beginning to erect themselves and dehisce. *a'* and a^2, longer and shorter stamens; *fi*, filaments; *st*, stigmas.

curved so far outwards and downwards that the stigmas are isolated in the middle of the flower, and must inevitably be touched by any insect visitors. In the second stage the flower is wide open, the six stamens of the inner whorl erect themselves and stand quite close to the stigmas, each stamen being brought between two of these, and the anthers dehisce extrorsely. Automatic self-pollination may now be easily effected, in consequence of the downwardly directed position of the flower; the spinose processes of the outer stamens also project beyond the stigmas, so that these are much less likely to be touched by visitors. Finally, the inner stamens erect themselves in succession and become inserted between the outer ones. They are somewhat shorter than the latter, their anthers being therefore situated exactly below the six still receptive stigmas. The mealy pollen falls into the flower in the form of yellow dust.

Visitors.—In spite of repeated prolonged watching in the Kiel Botanic Garden, Knuth only once observed a carrion-fly (Lucilia caesar *L.*), casually alighting.

2500. A. canadense L. (Delpino, op. cit.)—The flower mechanism of this species agrees with that of the preceding one.

2501. A. albivenium Regel (= Heterotropa asaroides *Morr. et Decne.*). (Delpino, op. cit.)—As regards the construction and mechanism of the flower, this species comes between Arum and Aristolochia. Delpino supposes that the inwardly curved margin of the perianth forms a temporary prison for the visitors, which are probably flies.

XCI. ORDER *LAURINEAE* VENT.

773. Laurus L.

2502. L. nobilis L.—

Visitors.—The following were recorded by the observers, and for the localities stated.—

Schletterer (Pola), the bee Halictus calceatus *Scop.*, var. obovatus *K.*, and the ichneumon-fly Bassus laetatorius *F.* Alfken (Bozen), the honey-bee Apis mellifica *L.* ☿, very freq., skg., the wasp Polistes gallicus *L.* ♀ and ♂, freq., the Sphegid Cerceris quinquefasciatus *Rossi*, freq., and the hover-fly Helophilus floreus *L.*, very freq., skg. and po-dvg.

XCII. ORDER *PROTEACEAE* JUSS.

Delpino ('Ult. oss.') says that species belonging to this order are protandrous. Self-pollination is undoubtedly excluded, for the pollen is generally removed by insect visitors before the stigmas are mature. Delpino supposes that various kinds of honey-sucking birds are visitors.

XCIII. ORDER *THYMELAEACEAE* JUSS.

774. Daphne Tourn.

Flowers homogamous, with nectar secreted and concealed in the base of the corolla-tube, and accessible to flies, bees, or Lepidoptera only according to the length of the latter. They thus belong to classes **C** to **L.**

2503. D. Mezereum L. (Herm. Müller, 'Weit. Beob.,' II, p. 236, 'Alpenblumen,' p. 207; Schulz, 'Beiträge,' II, pp. 159–60; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 301; Kirchner, 'Flora v. Stuttgart,' p. 423; Ludwig, 'Adynamandrie v. Erodium macradenum u. s. w.'; Knuth, 'Bloemenbiol. Bijdragen.'—The bright purple flowers of this species are strongly fragrant, thus attracting numerous bees, flies, and Lepidoptera, especially as the crowded blossoms are not hidden by foliage-leaves; nectar is secreted by the base of the ovary. Hermann Müller says that the proboscis of an insect probing for this first brushes against the two rows of anthers in the corolla-tube without removing their pollen, and then touches the stigma below them. Pollination will be effected if another flower has been previously visited. When the proboscis, wetted with nectar, is withdrawn, pollen adheres to it and is transferred to flowers visited later. If insect-visits fail, automatic self-pollination takes place by fall of pollen; this, however, does not seem to be always effective, for all flowers do not set fruits. Kerner says that autogamy seldom occurs on account of the horizontal position of the flowers.

Schulz observed gynomonoecism and, rarely, gynodioecism; he also found the flowers at Halle self-fertile. Ludwig, on the contrary, observed adynamandry at Greiz. He transplanted two stocks from different parts of a wood into his garden. They set abundant fruits for eight years, and then one of them died. In spite of frequent insect-visits and artificial transfer of the normal pollen to the fully mature stigmas, no fruits were set by the other plant. Ludwig adds:—

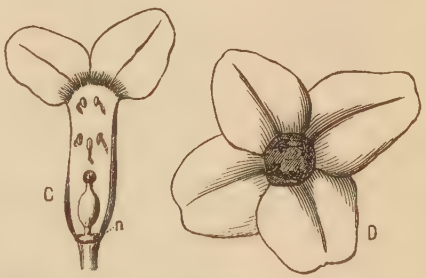


FIG. 358. *Daphne Mezereum*, *L.* (after Herm. Müller). *C.* A flower in longitudinal section; *n*, nectary. *D.* Flower from above.

'This case of adynamandry deserves special notice, as A. Schulz found the species to be self-fertile at Halle a. S., where self-pollination was always entirely effective. Adynamandry seems therefore to resemble dichogamy and other oecological adaptations in the various ways in which it can develop on one and the same plant in different places. It might be supposed *a priori* that adynamandry would be evolved in plants of xenocarpous origin in places where the species was abundant and insect-visits numerous after the melting of the snow, while in places where these conditions were reversed it would mean the extinction of the species.'

Miégeville (Bull. soc. bot., Paris, xxxv, 1887) describes small fertile and large sterile flowers belonging to this species.

VISITORS.—Knuth (Kn.), Herm. Müller (H. M.), and Ludwig (Lud.) almost the same insects, as given below. Considering that the species flowers early, when Lepidoptera, bees, and flies are scarce, it is not surprising that its conspicuous blossoms are visited by nearly all of them.—

A. Diptera. *Syrphidae*: 1. Eristalis tenax *L.* (Kn.), skg.; 2. E. sp. (H. M.), do. **B. Hymenoptera.** *Apidae*: 3. Anthophora pilipes *F.* ♂ and ♀ (Kn., H. M.), repeatedly and persistently skg.; 4. Apis mellifica *L.* ☿ (Kn., H. M., Lud.), freq., do.;

5. Bombus hortorum *L.* ♀, skg. (Kn.); 6. Halictus cylindricus *F.* ♀ (Kn., H. M.); 7. H. leucopus *K.* ♀ (H. M.); 8. H. minutissimus *K.* ♀; 9. H. nitidus *Schenck* ♀; all skg.; 10. Osmia fusca *Chr.* ♂ (H. M.); 11. O. rufa *L.* ♀ and ♂ (H. M.), skg. **C. Lepidoptera.** *Rhopalocera*: 12. Rhodocera rhamni *L.* (Kn., Lud.), skg.; 13. Vanessa urticae *L.* (Kn., H. M.), do.

Heinsius saw 2 long-tongued bees in Holland—Anthophora pilipes *F.* ♂, and Bombus terrester *L.* ♀ (Bot. Jaarb. Dodonaea, Ghent, iv, 1892, p. 79).

2504. D. striata Tratt. (Herm. Müller, 'Alpenblumen,' pp. 207–9; Schulz, 'Beiträge,' II, pp. 160–1.)—This species bears homogamous lepidopterid flowers smelling like elder. Their mechanism agrees with that of the preceding species, but the corolla-tube is so long and narrow that only Lepidoptera can obtain the nectar and effect pollination. Autogamy is possible by fall of pollen.

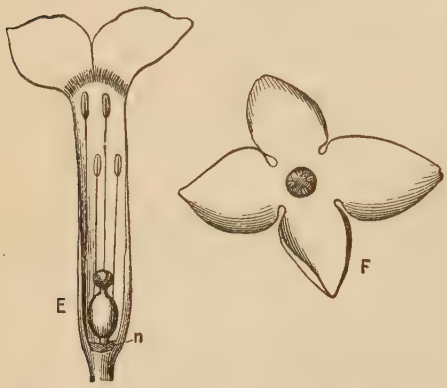


FIG. 359. *Daphne striata*, *L.* (after Herm. Müller). *E.* Flower in longitudinal section; *n*, nectary. *F.* Flower from above.

VISITORS.—Herm. Müller observed numerous Lepidoptera (9 species), and A. Schulz similarly.

2505. D. Laureola L. (MacLeod, 'Pyreneënbl.,' p. 440; Miégeville, Bull. soc. bot., Paris, xxxv, 1887.)—Miégeville describes small fertile and large sterile flowers for this species as for D. Mezereum. They are yellowish in colour and belong to class **L.**

VISITORS.—MacLeod saw a Lepidopterid in the Pyrenees, and Bonnier noticed the honey-bee.

2506. D. Cneorum L. (Briquet, 'Études de biol. flor. dans les Alpes occident.')—Briquet says that the red, fragrant flowers of this species are frequently visited by butterflies. The diameter of the perianth limb is 10–20 mm. The perianth tube narrows upwards, and the epiphyllous anthers are in two whorls, one 3–4 mm. above the other, while the capitate stigma is placed about 4 mm. deeper than the lower whorl. The lower part of the inner wall of the perianth tube secretes small drops of a sweet fluid. Butterflies effect cross- and self-pollination, and pollen can fall automatically upon the stigma of upright flowers. Kirchner adds that plants from Tuttlingen (Würtemberg) and Mount Salvatore (near Lugano) possessed a dark-green glandular disk at the base of the ovary, which secretes nectar as in D. Mezereum and D. striata.

VISITORS.—*Vide supra.*

2507. D. alpina L. (Briquet, op. cit.)—Briquet states that the four perianth lobes of the milk-white flowers belonging to this species diverge to give them a diameter of about 10 mm. In the perianth tube the eight anthers are situated in two whorls about 1–1½ mm. apart, and the capitate stigma is placed somewhat more

deeply. Neither nectar nor nectary has been observed. The flowers set abundant fruits.

Visitors.—These are Lepidoptera and flies, which must effect autogamy (Kirchner).

775. Thymelaea Tourn.

Flowers with concealed nectar.

2508. T. calycina Meissn. (= Passerina calycina *DC.*).—The flowers of this species are greenish-yellow in colour.

Visitors.—MacLeod (Pyrenees) saw a fly and a po-dvg. beetle.

2509. T. arvensis Lam. (= T. Passerina *Lange*, Stellera Passerina *L.*, and Passerina annua *Wikstr.*). (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 174, 365.)—Kerner says that self-pollination does not take place at first in the small, nectar-scented flowers of this species, as the sticky, clinging pollen does not fall automatically upon the stigma. At this time cross-pollination by insect-visits is possible. Towards the end of anthesis, however, the perianth contracts, so that the anthers are pressed against the stigma and autogamy is effected. If the weather is unfavourable the flowers do not open, and hemi-cleistogamous fertilization takes place.

2510. T. dioica All. (= Passerina dioica *Ram.*), and **2511. T. tinctoria** Endl. (= P. nivalis *Ram.*). (Miégeville, Bull. soc. bot., Paris, xxxv, 1887.)—Miégeville describes small sterile and large fertile flowers in these species.

776. Leucosmia Benth.

Darwin ('Different Forms of Flowers') and Hildebrand ('D. Geschlechts-Vert. b. d. Pfl.') describe species of this genus as dimorphous.

777. Pimelea Banks et Soland.

2512. P. ferruginea Labill. (= P. decussata *R. Br.*). (Willis, J. Linn. Soc., Bot., London, xxx, 1895.)—Willis says that the odourless flowers of this species are protandrous.

Visitors.—Willis observed flies in the Cambridge Botanic Garden.

XCIV. ORDER *ELAEAGNACEAE* R. BR.

778. Hippophae L.

Flowers anemophilous and dioecious.

2513. H. rhamnoides L. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 148, 150.)—In the male flowers of this species the dusty pollen falls from the four anthers into the base of the flower while still in the bud. Even after this has opened the pollen is protected from rain by the two bowl-shaped bracts, which remain fastened together at the apex: they only diverge laterally, so that two clefts are formed out of which the pollen is shaken by gusts of wind, when it may be transferred to female flowers. There is no nectar.

Visitors.—Verhoeff (Norderney) observed a hover-fly (Syrphus ribesii *L.*), searching for pollen.

779. Elaeagnus L.

Flowers entomophilous and hermaphrodite.

2514. E. angustifolia L. (Herm. Müller, 'Weit. Beob.,' II, p. 234.)—The flowers of this species are citron-yellow in colour internally, silver-white externally.

Visitors.—Herm. Müller, on garden plants, observed the honey-bee, skg., and the hover-fly Syritta pipiens, *L.*, skg.

XCV. ORDER *LORANTHACEAE* DON.

780. Viscum Tourn.

Flowers dioecious and entomophilous, with exposed to half-concealed nectar.

2515. V. album L. (Kölreuter, 'Fortsetzung,' pp. 70–2; Loew, Bot. Centralbl., Cassel, xliii, 1890, pp. 129–32.)—Kölreuter declared positively in 1762 that mistletoe is entomophilous, but the plant was considered anemophilous for a long time, until Loew's investigations proved entomophily beyond doubt. In view of the interest to which Kölreuter's description has a claim, I should like to quote from him:—

'I wish to add a few words regarding an observation which I made last spring on mistletoe. It concerns the quite peculiar construction of those organs which contain pollen, and give it out when ripe, and the only method which Nature employs for the pollination of female plants.

'A very unsuitable name would be chosen if these organs were called anthers, as in most other plants. They are nothing but a projecting spongy region of a whitish colour, which in the male flower occupies most of the inner surface of the perianth, and is closely fused with it. It is formed of a cellular tissue (parenchyma) through which many hollow passages run in various directions; these are connected with one another, and are intended to receive the pollen-grains as they are produced by the cells, and finally to let them escape by certain rounded openings into the cavity of the still closed flower.

'The male flowers do not open all at once, and, as it were, by force, but gradually, scattering the pollen resting within them into the air. The pollen-grains are sulphur-yellow in colour, ovoid in shape, and beset externally with very short slender spines, which are the chief cause of their clinging together.

'The pollination of female plants, whether growing on the same tree with male stocks or on separate ones at a great distance, is effected entirely by insects, and indeed chiefly by various genera of flies, which eagerly seek the pollen and the sweet fluid secreted by both kinds of flowers and provided as food for them by Nature. The pollen clings to their hairy bodies and is transferred from the male plants to the flowers of female ones. If the nature and quantity of pollen be considered and attention be given to that which happens to these plants during anthesis, it will be easily seen that it would be vain to expect pollination by wind in this case. I therefore place the mistletoe, without further thought, among those plants pollinated only by insects; and, so far as I know, it is the first plant in the vegetable kingdom of which it can be said that its fertilization is dependent on insects and its propagation on birds, and that its preservation depends on animals belonging to two quite distinct classes. Doubtless, also, on the other hand, considering their scanty means of

sustenance, these animals in their turn are preserved by the existence of the plant; a new example by which the exact and necessary interdependence of all things is clearly seen.'

This masterly description, confirmed about 130 years later by Loew's entirely independent investigations, is a further testimony to the acuteness, as well as to the thoroughness and detail of Kölreuter's observations. Loew describes the flower mechanism somewhat as follows.—The tetramerous, leathery perianth is of a yellowish-green colour, and larger in male flowers than in female ones; the lobes of the former are about 3 mm. long and rather less broad, those of the latter only 1 mm. in breadth and about the same in length. There are numerous pollen-receptacles on the inner side of the cup-shaped perianth of the male flower. The pollen is not dry and powdery, however, but of a coherent nature, and beset, as Mohl has described it, with fine short spines. The inner hollow of the base of the perianth is covered by a nectary.

The perianth lobes of the smaller female flowers incline together towards the thick, short, capitate stigma, which in transverse section is bluntly rectangular and about ·5 mm. high. In this case the nectary forms a feebly glandular ring, situated between the base of the perianth and that of the capitate stigma, which at this point is contracted to a kind of neck.

Entomophily is indicated by the flower's striking odour of orange, as well as by the secretion of nectar. In addition to this may be mentioned the nature and comparatively small amount of pollen, and the fact that the male flowers are larger and perhaps also more strongly fragrant than the female ones. The nectar is situated 3–4 mm. deep in the former and is perfectly accessible to an insect probing from above; Loew says, therefore, that the male flowers belong to class **E.** In the smaller female flowers the perianth lobes usually so cover the nectary that only the upper surface of the capitate stigma is accessible from outside; Loew therefore considers the female flowers as belonging to class **EC.**

Loew was unable to observe pollinators; but supposed these to be short-tongued bees. The entrance to the male flower is so narrow (2 mm.), and the inner surface of the perianth so thickly lined with pollen, that a bee with proboscis 3–4 mm. long or even shorter, in probing for nectar, would dust this and its entire head with pollen, which it would inevitably transfer to the stigma of a female flower when probing between the perianth lobes and the capitate stigma. Loew thinks early flying species of Andrena are the pollinators, some of which (A. albicans, A. tibialis, A. praecox, A. parvula, A. fulva, and others) appear as early as the middle of March, the flowering time of mistletoe. As in the case of the willows, which are usually visited by these bees, the mistletoe clumps attract visitors entirely by the fragrance of their nectar, for the usual conspicuousness seems to be unnecessary so early in the year when bright flowers are rare.

Kölreuter, as previously described, observed 'chiefly many genera of flies' as visitors; these also are able to reach the nectar, which is situated only a few millimetres deep, and thus to effect fertilization in the manner described by Loew.

Lindman describes mistletoe as monoecious near Stockholm. He compares (Bot. Centralbl., Cassel, xliv, 1890, pp. 241–4) the fragrance of the mistletoe-flower with that of apples, or rather of apple-must; the odour of male flowers is much

stronger than that of female ones. The young branches are of a rather bright ochre-yellow, which gives the plant a certain conspicuousness; the large, thick internode below the small inflorescence may be considered as an excellent extra-floral device to attract attention.

Kirchner (Jahreshefte Ver. Natk. Stuttgart, xlix, 1893, p. 104) confirms Lindman's observations regarding the fragrance. He says that both male and female flowers clearly secrete nectar, the male ones usually less than the female, the latter being sometimes full up to the tips of the perianth lobes. These in the male flower at the beginning of anthesis are so upright that the brittle pollen bursting from its receptacles bars the way to the base of the blossom, and must therefore adhere to the proboscis of an insect probing for nectar. In the course of anthesis the perianth lobes diverge more widely.

Visitors.—The following were recorded by the observers stated.—

Kirchner, the honey-bee, only visiting the male stocks, and leaving alone the smaller, feebly odorous, female flowers, which of course yield no pollen. Pollination is effected by flies (Pollenia rudis *F.*, freq.; P. vespillo *F.*, do.; Spilogaster duplicata *Mg.*, less freq.) which visit flowers of both kinds. Bonnier saw the honey-bee.

XCVI. ORDER *SANTALACEAE* R. BR.

781. Thesium L.

Flowers homogamous with concealed nectar secreted at the base of the corolla-tube. Kerner ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 125) says that the anthers which have dehisced in dry weather close up again when it is damp. Heterostyly sometimes occurs.

2516. T. alpinum L. (Herm. Müller, 'Alpenblumen,' pp. 206–7; Schulz, 'Beiträge,' II, p. 161; Kerner, loc. cit.; Ewart, Ann. Bot., Oxford, vi, 1892, pp. 271–90.)—The corolla tube of the homogamous flowers of this species is only 2 mm. deep. When visited by insects, cross-pollination is favoured (according to Hermann-Müller), as anthers and stigma come into contact with opposite sides of the insects' bodies. Should such visits fail, automatic self-pollination takes place towards the end of anthesis when the flower closes, by contact of anthers and stigma. Schulz says that this is less easily effected in plants in the Riesengebirge.

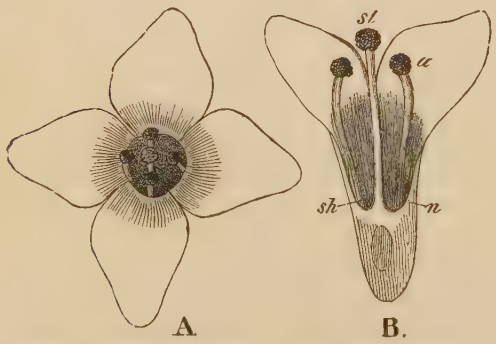


Fig. 360. *Thesium alpinum*, *L.* (after Herm. Müller). *A* Flower seen from above. *B*. Do., in longitudinal section (× 13). *n*, nectary; *sh*, nectar receptacle; *st*, stigma.

Kerner states that the anthers, after having been pollinated, close up in half a minute. The walls of the anthers are rendered damp by means of a characteristic tuft of hairs growing on the perianth, which Kerner describes as follows:—

'The anthers of the Bastard Toad-flax (*Thesium alpinum*) shut up within thirty seconds of their being moistened. In this plant the process of closing is rendered additionally interesting by the fact that the moistening of the anther-walls is effected by peculiar tufts of hair projecting from the perianth. . . . The open flower of *Thesium* has the limb of its perianth turned to the sky. The position is maintained unchanged day and night, and even the occurrence of bad weather does not cause any alteration in the direction of the flower-stalks or the position of the flowers. Hence rain-drops falling from above and the dew formed on clear nights must inevitably rest on the open flowers. The immediate wetting of the entire flower is, however, prevented by peculiarities in the form of the limb. The anthers close with great celerity upon the deposition of the drops, the explanation being that the perianth lobes are connected with the anthers standing in front of them by a bunch of twisted hairs, which not only are themselves peculiarly susceptible of being wetted, but conduct the water to the anthers and so cause the anther-walls to close.'

These hairs have been anatomically examined by Miss M. F. Ewart, who distinguishes between two kinds:—

(1) Short, thick hairs, directed downwards towards the base of the style.

(2) Long, thin ones, directed upwards towards the anthers.

The former are situated on each side of the anthers and spring from the inner surface of the perianth; the others stand behind each anther. Both kinds secrete resin, which often fastens the longer hairs to the anthers. Many species also possess long threads hanging from the perianth leaves.

Two groups connected by transitions may be distinguished:—

(1) Species, such as T. spicatum and T. capituliflorum, possessing short, downwardly directed hairs at each side of the anthers and long threads hanging from the perianth. The style in these species is short and the perianth lobes much thickened.

(2) Species, such as T. debile and T. paniculatum, possessing long, upwardly directed hairs situated behind the anthers and the short or small threads on the perianth. The style is long and the perianth lobes scarcely thickened.

Miss Ewart says that the hair-tufts on flowers of the first group probably serve to hold the pollen firmly by means of the excreted resin, while the hanging threads guide the insect visitor to the deeply situated stigma.

In flowers of the second group these threads are not necessary, on account of the length of the style. The threads situated behind the anthers do not serve (in Miss Ewart's opinion) as supports for them, but probably prevent the insect probing for nectar from diverging from the right way, and also hold back the pollen close to the flower-entrance.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Schulz (Riesengebirge), 50 Hymenoptera (mostly small), as many flies, and a few small beetles. Herm. Müller (Alps), not a single visitor. MacLeod (Pyrenees), a Muscid (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 440).

2517. T. intermedium Schrad. (Schulz, 'Beiträge,' II, pp. 161–3.)—The flowers of this species are heterostylous and homogamous. In the long-styled form the anthers reach just above the middle of the style, and automatic self-pollination is therefore rendered difficult. In the short-styled form the anthers are situated

immediately above the stigma, so that automatic self-pollination by fall of pollen is inevitable. The size of the pollen-grains and stigmatic papillae does not vary essentially in the two forms. Homostylous flowers also occur sometimes.

Although the honey-odour is not particularly strong to our sense of smell, it is so extremely attractive to bees, that (according to Schulz) these insects neglect all other flowers, however brilliant in colour, if nectar is not so abundant in them as in this species. This investigator saw bees fly straight to this plant from a distance of from 40 to 50 m., or even further; they could not have seen anything of its leaves or flowers, but they passed over numerous others, blue and red in colour, which they did not despise at other times. Schulz concluded, therefore, that it is not the colour, as is generally supposed, but the specific smell of nectar which forms the chief attraction to visitors.

Visitors.—Schulz (Halle and S. Tyrol), many small bees, flies, and beetles, and a few Lepidoptera.

2518. T. pratense Ehrh. (Kirchner, 'Flora v. Stuttgart,' p. 521; Herm. Müller, 'Weit. Beob.,' II, p. 235.)—The perianth in this species is green outside and white inside, and 5–6 mm. in diameter. The flowers are homogamous, but the stigma is persistent. It outlives the stamens and is still receptive when the anthers have shrivelled and fallen. These dehisce introrsely and become covered all over with pollen. The stamens are of the same length as the stigma, and situated very near it, so that self- and cross-pollination may be effected with equal facility by insects probing for the nectar secreted at the base of the flower. Should such visits fail, automatic self-pollination may easily take place in consequence of the proximity and simultaneous maturation of stigmas and anthers.

Visitors.—Herm. Müller observed the honey-bee, skg.

2519. T. bavarum Schrank (= T. montanum *Ehrh.*). Kirchner, 'Flora v. Stuttgart,' p. 522.)—The flower mechanism of this species resembles that of the preceding one, but the stigma projects about a mm. beyond the anthers, so that cross-pollination is favoured by insect-visits, and automatic self-pollination rendered difficult should these fail.

XCVII. ORDER *EUPHORBIACEAE* JUSS.

782. Buxus L.

Flowers monoecious with exposed nectar, probably occasionally anemophilous.

2520. B. sempervirens L. (Herm. Müller, 'Weit. Beob.,' II, pp. 214–15; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 138, 173, 313; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Knuth, 'Bloemenbiol. Bijdragen.')—The flowers of this species are yellowish-green in colour, and therefore rather inconspicuous. They are also odourless, but the yellow anthers of the male flowers, which protrude while the bud is still closed, are so conspicuous that visitors are fairly numerous, the plant flowering so early in the year (March and April) that there are very few other flowers at their disposal from which they can obtain nectar.

The apical flower of the crowded spike is female; it is surrounded by six or more male ones, each of which possesses four thick anthers. Both kinds of flowers

offer a small quantity of nectar to visitors, the female possessing three small, fleshy nectaries close together, each secreting a small drop of nectar. These are situated touching each other on the ovary, which is surrounded by five or six greenish perianth leaves. In the male flowers the vestigial ovary forms the nectary, apparently secreting tiny drops of nectar. The three styles in the female flowers alternate with the nectaries, and project beyond them, each bearing a two-lobed stigma on its inner side; no trace of anthers is to be seen. In the male flowers the four stamens project far beyond the nectary, which is surrounded by the four perianth leaves. The anthers are thick and cordate.

The spikes are feebly protogynous. The stigmatic papillae of the apical flower (which is sometimes absent) are receptive before the anthers of the surrounding male flowers have dehisced, and the stigmas remain in that condition until all the male flowers on the spikelet have shed their pollen. The apical flower can therefore easily be pollinated by insect visitors with pollen from adjacent male ones, if it has not already been dusted with that of others belonging to the same or another plant. Visitors, however, usually fly to the middle of the spikelet, which affords the most convenient alighting-platform, and therefore on to the female flower, so that even in the homogamous stage of the spikelet crossing with separate stocks is generally effected.

Warnstorf describes the pollen-grains as whitish in colour, spheroidal, rendered opaque by low, crowded tubercles, on an average 37 μ in diameter.

Kerner places the box among those anemophilous species which—like most ashes, the mock-privet (Phillyrea), and the pistachio (Pistacia)—bear short, thick filaments and comparatively large anthers filled with mealy pollen, although he has expressly stated that the male as well as the female flowers possess three central nectaries each secreting a drop of nectar.

Visitors.—The following were observed by Herm. Müller (H. M.) and Knuth (Kn.).—

A. Diptera. (*a*) *Muscidae*: all skg.: 1. Calliphora vomitoria *L.* (Kn.); 2. Musca corvina *F.* (H. M.); 3. M. domestica *L.* (Kn., H. M.). (*b*) *Syrphidae*: 4. Syritta pipiens *L.*, skg. or po-dvg. (H. M.); 5. Syrphus pyrastri *L.*, do. (H. M.). **B. Hymenoptera.** *Apidae*: 6. Apis mellifica *L.* ☿ (Kn., H. M.), po-cltg. Herm. Müller describes the behaviour of the honey-bee as follows: 'It frees the pollen from the still undehisced anthers with its mandibles, regurgitates some honey from its slightly protruded proboscis, and then transfers the pollen by means of the front and mid legs to the hind ones. All this, however, is done so quickly that the individual acts can scarcely be followed.'

783. Euphorbia L.

Literature.—Delpino, 'Ult. oss.,' I, pp. 157–61; Herm. Müller, 'Weit. Beob.,' II, p. 215; Kirchner, 'Flora v. Stuttgart,' p. 365; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 124, 173, 313; MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, pp. 249–50; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 130–1, 'Grundriss d. Blütenbiol.,' pp. 90–1.

All our native spurges possess the same flower mechanism. The stem at first divides into a pentamerous cyme, the rays subdividing into branches with bifurcated branchlets. An inflorescence resembling a single flower is situated at the end of each

branchlet. This is composed of several (10–12) male flowers (each consisting of a single-stalked stamen) with a central female flower, and is surrounded by a calyciform involucre with a four- to five-lobed limb. The glands of this investment secrete a shallow layer of completely exposed nectar.

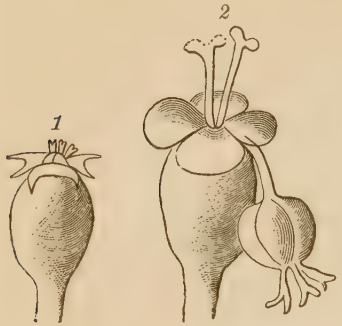


FIG. 361. *Euphorbia*, *L.* (from nature). (1) *E. Peplus*, *L.*, in the first (female) stage; the stigmas project a little from the involucre. (2) *E. Helioscopia*, *L.*, in the second (male) stage; the ovary (the female flower) with its non-receptive stigmas hangs far out on a curved stalk: the stamens (male flowers) protrude from the involucre.

This inflorescence, oecologically equivalent to a single flower, is strongly protogynous (*cf.* E. palustris *L.*). The three bilobed stigmas emerge first from the involucre, and may be dusted with foreign pollen if insects visit the flowers. Later, when the ovary (on a long, curved stem) projects far beyond the involucre, the stamens gradually elongate one after another, dehiscing at the same time, and take the place which was occupied in the first stage by the stigmas. Pollination is effected exclusively by flies, but beetles and wasps are occasional visitors, and, in places where the plants grow in large numbers close together, bees may also be observed.

Kerner states that the anthers close in damp air and open again when it is dry. Jordan observed that they turn their pollen-covered sides to the flower entrances above the nectaries.

2521. E. helioscopia L.—

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller, Anthomyia sp. and other flies. Knuth ('Bl. u. Insekt. a. d. nordfr. Ins.,' p. 167), 5 **Diptera**—(*a*) *Muscidae*: 1. Anthomyia sp. (*b*) *Syrphidae*: 2. Melanostoma mellina *L.*; 3. Syritta pipiens *L.*; 4. Syrphus balteatus *Deg.* (*c*) *Tipulidae*: 5. Pachyrhina sp. Knuth (Helgoland, Bot. Jaarb. Dodonaea, Ghent, viii, 1896, p. 36), 5 **Diptera**—(*a*) *Muscidae*: 1. Coelopa frigida *Fall.*; 2. Fucellia fucorum *Fall.*; 3. Lucilia caesar *L.* (*b*) *Syrphidae*: 4. Chrysotoxum festivum *L.* ♂; 5. Eristalis tenax *L.* MacLeod (Flanders, op. cit., vi, 1894, p. 379), 2 hover-flies. Plateau (Flanders), a bee (Proscopis sp.) and a hover-fly (Syrphus corollae *F.*). Schletterer (Pola), a bee (Halictus calceatus *Scop.*), a Sphegid (Salius fuscus *F.*), and a saw-fly (Arge cyaneocrocea *Först.*). Delpino, only flies.

2522. E. verrucosa Lam.—

VISITORS.—Loew (Berlin Botanic Garden) observed a Muscid (Lucilia caesar *L.*) and 2 hover-flies (Ascia podagrica *F.*, and Eristalis nemorum *L.*) ('Blütenbiol. Floristik,' p. 332).

2523. E. Gerardiana Jacq.—

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Loew (Berlin Botanic Garden, loc. cit.), the honey-bee and a fossorial wasp (Crabro lapidarius *Pz.* ♀). Plateau (Ghent), 3 flies—1. Eristalis arbustorum *L.*;

2. Lucilia caesar *L.*; 3. Syritta pipiens *L.* Herm. Müller (Kitzingen), 4 nect-lkg. beetles—(*a*) *Cerambycidae*: 1. Leptura livida *F.*, nect-lkg.; 2. Strangalia melanura *L.* (*b*) *Mordellidae*: 3. Mordella aculeata *L.*; 4. Mordellistena pumila *Gylh.*

2524. E. Cyparissias L. (Sprengel, 'Entd. Geh.,' p. 266; Herm. Müller, 'Alpenblumen,' pp. 172–3, 'Weit. Beob.,' II, p. 216.)—

Visitors.—Herm. Müller (H. M.) and Buddeberg (Budd.) give the following list for Central Germany.—

A. Coleoptera. (*a*) *Cerambycidae*: 1. Phytoecia nigricornis *F.*, nect-lkg. (Budd.). (*b*) *Chrysomelidae*: 2. Cryptocephalus flavipes *F.* (Budd.); 3. Haltica sp., freq. (H. M., Thuringia); 4. Luperus circumfusus *Marsh.* (Budd.). (*c*) *Elateridae*: 5. Corymbites aeneus *L.*, nect-lkg. (Budd.); 6. Cryptohypnus minutissimus *Germ.*, nect-lkg. (Budd.). (*d*) *Telephoridae*: 7. Cantharis sp., nect-lkg. (Budd.). (*e*) *Mordellidae*: 8. Mordella aculeata *L.*, nect-lkg. (Budd.). **B. Diptera.** (*a*) *Muscidae*: 9. Anthomyia sp. ♀, freq., skg. (Budd.). (*b*) *Syrphidae*: 10. Cheilosia sp., skg. (Budd.); 11. Eristalis arbustorum *L.*, do. (H. M.); 12. E. tenax *L.*, do. (H. M.). **C. Hemiptera.** 13. Lygaeus equestris *L.* (H. M.); 14. Miris levigatus *L.* (Budd.); 15. Stenocephalus agilis *Scop.* (Budd.). **D. Hymenoptera.** (*a*) *Apidae*: 16. Andrena convexiuscula *K.* ♂, skg. (Budd.); 17. Halictus flavipes *F.* ♀, skg. (Budd.); 18. H. villosulus *K.* ♀, skg. and po-cltg. (H. M.); 19. Sphecodes gibbus *L.* ♀, skg. (Budd.). (*b*) *Chrysididae*: 20. Chrysis ignita *L.* ♀, nect-lkg. (H. M.). (*c*) *Tenthredinidae*: 21. Allantus temulus *Scop.*, in large numbers, nect-lkg. (Budd.); 22. Amasis laeta *F.*, nect-lkg. (Budd.); 23. Hylotoma ustulata *L.*, do. (Budd.); 24. Macrophya ribis *Schr.*, do. (Budd.). (*d*) *Vespidae*: 25. Eumenes pomiformis *F.*, skg. (H. M.). **E. Lepidoptera.** 26. Hesperia sylvanus *Esp.*, skg. (H. M., Thuringia).

The following were recorded by the observers, and for the localities stated.—

Loew (Brandenburg, 'Beiträge,' p. 36), a Sphegid (Cheilosia praecox *Zett.*, skg.) and 2 hover-flies (Chrysotoxum vernale *Lw.*, skg., and Eristalis nemorum *L.*, do.): (Silesia, op. cit., pp. 29, 48), a Therevid (Thereva microcephala *Loew*) and a hover-fly (Melanostoma mellina *L.*, skg.). Schmiedeknecht (Thuringia), 2 bees—Andrena fulvida *Schenck*, and A. proxima *K.* Friese (Thuringia), the saw-fly Tenthredo ignobilis *Klug.* Krieger (Leipzig), the 2 commonest fossorial wasps Pompilus viaticus *L.*, and Salius fuscus *F.* Herm. Müller (Alps), 21 Diptera, a beetle, and 3 Lepidoptera. Schletterer, for Pola and the Tyrol (T.), a bee (Halictus tetrazonius *Klg.* ♀ (T.), a saw-fly (Arge cyaneocrocea *Först.*), and a wasp (Polistes gallica *L.*). F. F. Kohl (Tyrol), the Chrysididid Ellampus aeneus *F.*

2525. E. palustris L. (Heinsius, Bot. Jaarb. Dodonaea, Ghent, iv, 1892, pp. 59–61; Loew, 'Blütenbiol. Floristik,' p. 165.)—Heinsius says that the inflorescences of this species are partly protandrous and partly protogynous; those situated in the middle and flowering first being protandrous, and those nearer the outside protogynous.

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Coleoptera. (*a*) *Dermestidae*: 1. Anthrenus scrophulariae *L.*, nect-lkg. (*b*) *Scarabaeidae*: 2. Cetonia aurata *L.*, dvg. the flowers. **B. Diptera.** (*a*) *Bibionidae*: 3. Bibio hortulanus *L.* ♀, skg.; 4. B. marci *L.* ♂, do. (*b*) *Empidae*: 5. Hilara maura *F.*, skg. (*c*) *Muscidae*: 6. Anthomyia sp.; 7. Sarcophaga carnaria *L.* (*d*) *Syrphidae*: 8. Eristalis nemorum *L.*; 9. Melanostoma mellina *L.*, skg.; 10. Syritta pipiens *L.*, do. **C. Hymenoptera.** *Apidae*: 11. Andrena fasciata *Wesm.* ♀, po-cltg.; 12. A. fulva *Schr.* ♀, do.; 13. A. nitida *Fourcr.* ♀, skg. and po-cltg.; 14. Apis mellifica *L.* ☿, eagerly skg., and removing pollen while creeping over several cyathia.

Heinsius observed the following in Holland.—

A beetle (Oedemera flavipes *F.* ♂ and ♀), 5 Muscids (1. Anthomyia sp. ♂; 2. Cyrtoneura curvipes *Macq.* ♂; 3. C. hortorum *Fall.* ♀; 4. Graphomyia maculata *Scop.* ♀; 5. Onesia floralis *R. D.* ♂), a Bibionid (Dilophus vulgaris *Mg.* ♂), a Stratiomyid (Odontomyia tigrina *F.* ♂ and ♀), and 2 Syrphids (Ascia podagrica *F.* ♀, and Chrysogaster splendida *Meig.* ♀).

2526. E. Esula L.—

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Thuringia, op. cit.), 3 Muscids (1. Anthomyia sp., nect-lkg.; 2. Sepsis sp.; 3. Ulidia erythrophthalma *L.*, nect-lkg.), an ant (Myrmica ruginodis *Nyl.* ☿, nect-lkg.), and Ichneumonids. Knuth (Kiel Ober-Realschule Garden, 'Beiträge'), the hover-fly Eristalis tenax *L.*, nect-lkg. Loew (Berlin Botanic Garden), the honey-bee, skg. and po-cltg. von Dalla Torre (Innsbruck Botanic Garden), the bee Prosopis bipunctata *F.* (also recorded by Schletterer).

2527. E. Peplus L.—Warnstorf describes the pollen-grains of this species as yellow in colour, tetrahedral, tuberculate, on an average 56 μ broad and up to 75 μ long.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 167), 4 hover-flies, minute Muscids, and a beetle: (Helgoland, Bot. Jaarb. Dodonaea, Ghent, viii, 1896, p. 36), 2 Muscids (Coelopa frigida *Fall.*, and Lucilia caesar *L.*), and a Syrphid (Eristalis tenax *L.*). Herm. Müller (Thuringia), an ant (Lasius sp. ☿), small flies, and Ichneumonids. MacLeod (Flanders, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, pp. 251, 379), 3 hover-flies, 2 short-tongued Hymenoptera, and a beetle. Plateau (Flanders), a bee (Andrena nana *K.*), and a hover-fly (Syrphus corollae *F.*).

2528. E. pilosa L.—

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Diptera. (*a*) *Bibionidae*: 1. Bibio hortulanus *L.* ♀, skg. (*b*) *Muscidae*: 2. Lucilia caesar *L.*; 3. Spilogaster duplicata *Mg.* **B. Hymenoptera.** *Apidae*: 4. Andrena fulva *Schr.* ♀, po-cltg.; 5. Halictus sexnotatus *K.* ♀, skg. and po-cltg.

2529. E. dulcis L.—Kerner describes this species as very strongly protogynous, but with inconspicuous inflorescences.

2530. E. platyphyllos L.—

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Thuringia), Diptera, Sphegids (e. g. Crabro brevis *v. d. L.*), and bees. Plateau (Ghent), a hover-fly (Syritta sp.) and numerous Muscids.

2531. E. aspera Bieb.—

Visitors.—Loew observed the following in the Berlin Botanic Garden.—

A. Diptera. (*a*) *Muscidae*: 1. Anthomyia sp., skg.; 2. Lucilia caesar *L.*; 3. Sarcophaga carnaria *L.* (*b*) *Syrphidae*: 4. Eristalis nemorum *L.*, skg. **B. Hymenoptera.** *Apidae*: 5. Andrena albicans *Müll.* ♂, skg.; 6. A. dorsata *K.* ♀, po-cltg.

2532. E. nicaeënsis Al.—

Visitors.—Loew (Berlin Botanic Garden) observed the following.—

A. Diptera. (*a*) *Muscidae*: 1. Anthomyia sp. (*b*) *Syrphidae*: 2. Eristalis nemorum *L.* **B. Hymenoptera.** *Apidae*: 3. Halictus nitidiusculus *K.* ♀, skg. and po-cltg.

2533. E. salicifolia Host.—

Visitors.—Loew (Berlin Botanic Garden) observed a Dermestid beetle (Anthrenus scrophulariae *L.*, nect-lkg.) and 2 hover-flies (Helophilus floreus *L.*, skg., and Syritta pipiens *L.*).

2534. E. virgata Waldst. et Kit.—

Visitors.—The following were recorded by the observers, and for the localities stated.—

F. F. Kohl (Innsbruck Botanic Garden), the Vespid Odynerus nigripes *H.-Sch.* Plateau (Brussels Botanic Garden), the honey-bee, freq., a Muscid (Lacilia caesar *L.*), and hover-flies (Eristalis arbustorum *L.*, and other sp.).

2535. E. amygdaloides L.—

Visitors.—Bonnier saw the honey-bee, freq., skg.

2536. E. segetalis L.—The flowers of the species are greenish-yellow in colour.

Visitors.—Plateau observed a bee (Halictus sp.), a hover-fly (Syritta pipiens *L.*), Muscids, and Thrips.

2537. E. dendroides L. (Knuth, 'Blütenbiol. Beob. a. d. Ins. Capri,' pp. 15–17.)—

Visitors.—Knuth (Capri) observed the following.—

A. Coleoptera. 1. Coccinella septempunctata *L.* **B. Diptera.** (*a*) *Muscidae*: 2. Sarcophaga carnaria *L.*; 3. Scatophaga stercoraria *L.* (*b*) *Syrphidae*: 4. Eristalis tenax *L.*; 5. Syrphus sp. **C. Hymenoptera.** (*a*) *Apidae*: 6. Andrena sp. (*b*) *Formicidae*: 7. Formica sp.

2538. E. ceratocarpa Tenore; **2539. E. officinarum** L.; and **2540. E. splendens** Boj.—Nicotra states that these species are dioecious ('Contrib. alla biol. fior. d. gen. Euphorbia,' Fasc. i, Palermo, 1824).

784. Dalechampia Plum.

2541. D. Roezliana Muell.—Francke, whose observations were made in the Freiburg i. B. Botanic Garden, states that in this species the pollination of female flowers is not excluded but rendered difficult.

785. Ricinus L.

2542. R. communis L. (Delpino, Malpighia, Genova, iii, 1889.)—This species is strongly anemophilous, as shown by the explosive dehiscence of the anther-lobes.

786. Phyllanthus L.

2543. P. Niruri L. (?) (Ludwig, Kosmos, Leipzig, i, 1872.)—This species is indigenous to Brazil. At the base of the inflorescence are situated smaller whitish-green, bell-shaped male flowers provided with nectaries, and above them the larger green female ones with longer stalks, devoid of nectar. Anthesis begins by the almost simultaneous opening of the male and female flowers situated in the lowest part of the inflorescence.

Visitors.—Ludwig and Herm. Müller supposed these to be small Diptera.

787. Mercurialis L.

Flowers anemophilous; dioecious, rarely monoecious, still more rarely tri-monoecious.

2544. M. annua L. (F. Heyer, Inaug.-Diss., Halle, 1883.)—Heyer says that the ratio of male to female plants in this species is as 105·86 : 100 (on the average calculated from 21,000 specimens). Monoecism occurs sometimes, single male flowers appearing on the female plants, or conversely. Pollen is transferred from one plant to another by the wind.

The development of germinable seeds without fertilization, i. e. parthenogenetically, has already been described in Vol. I, p. 61.[1]

Visitors.—The following were recorded by the observers, and for the localities stated.—

MacLeod (Flanders), 2 hover-flies (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 252). Plateau (Flanders), a Dermestid beetle (Anthrenus verbasci *L.*, freq., po-dvg.), Thrips, a moth (Botys sp.), and 4 hover-flies—1. Syritta pipiens *L.*; 2. Syrphus corollae *L.*; 3. Eristalis tenax *L.*; 4. E. arbustorum *L.*

2545. M. perennis L. (Thomas, Bot. Centralbl., Cassel, xv, 1883, p. 29; J. Saunders, J. Bot., London, xxi, 1883, pp. 181–2; Warnstorf, Schr. natw. Ver., Wernigerode, xi, 1896.)—Thomas describes this species as dioecious, and occasionally monoecious, while Saunders states that it is also sometimes trioecious. Warnstorf describes the male flowers as arranged in clusters of 4 to 7, grouped in pseudo-spikes of which the apical flower opens first. The two globular, yellow anthers, situated upon pale delicate filaments, diverge and dehisce upwards. The anther-lobes become indigo-blue in colour after the pollen-grains are scattered. These are sulphur-yellow in colour, closely tuberculate, ellipsoidal, on an average 37 μ long and 20 μ broad. Kerner says that the stigmas of the female flowers are receptive at least two days before the anthers of the male ones dehisce ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 403).

[1] Juel (Vet.-Ak. Handl., Stockholm, xxxiii, 1900) says that in this species there is no real parthenogenesis (i. e. the development of a new individual from a cell which is morphologically an unfertilized egg-cell), but only seed-formation without previous fertilization. This also applies to Caelebogyne ilicifolia, *J. Sm.* (vol. i, p. 60), some species of Alchemilla (Murbeck, Bot. Not., Lund, 1897, p. 273), as well as to the plants of Antennaria alpina in the Innsbruck Botanic Garden, which are described by Kerner as parthenogenetic. Juel (op. cit.) proves by his investigations on the embryology of this plant that 'Kerner's hitherto unproved assertion of parthenogenesis in Antennaria alpina is nevertheless true.'

Visitors.—Scott-Elliot (Dumfriesshire) observed the honey-bee ('Flora of Dumfriesshire,' p. 152).

2546. M. ovata Sternb. et Hoppe (= M. perennis *L.*, according to the *Index Kewensis*).—Kerner's remark about the last species applies to this one also. A. H. W. Dod (J. Bot., London, xxxiii, 1895, p. 185) observed several male plants with one or two female flowers, and one female plant with one male flower.

Visitors.—Frey (Aargau) observed the moth Brephos puella *Esp.*

XCVIII. ORDER *URTICACEAE* ENDL.

788. Urtica L.

Flowers anemophilous; monoecious or dioecious. When they open, the filaments, hitherto curved inwards and downwards, expand and spring out of the perianth, the anthers dehiscing at the same time and scattering their pollen in a small cloud.

2547. U. urens L. (Herm. Müller, 'Weit. Beob.,' I, pp. 294–5; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 313; MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, pp. 134–5.)—The female flower in this species is one mm. long and 0·5 mm. broad. It consists of a green tetramerous perianth, and an ovary bearing a tuft of radiating transparent stigmatic hairs. The male flower matures somewhat later than the female one in the same leaf-axil, and its diameter is four times that of the latter. The four stamens are superposed on the four perianth leaves, and are bent so far inwards that the thick anthers lie in the base of the flower, while the inwardly curved filaments are in a condition of outward tension. This increases as they elongate until the resistance is finally overcome. The filaments suddenly straighten, the anthers dehiscing simultaneously and scattering a cloud of pollen, thus effecting crossing with adjacent stocks in which the stigmas are already receptive.

2548. U. dioica L.—The male flowers of this species possess the same explosive mechanism as those of U. urens, but dioecism is the usual rule. Monoecious stocks occur, however, bearing female inflorescences at the top, mixed ones in the middle, and male ones at the bottom (Hildebrand).

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller, the hover-fly Syrphus arcuatus *Fall.* (?), po-dvg. Von Fricken (Westphalia and E. Prussia) and Redtenbacher (Vienna), the Nitidulid beetle Brachypterus urticae *F.*

789. Parietaria L.

Flowers anemophilous; trioecious—there being hermaphrodite, male and female flowers on the same stock. The hermaphrodite ones are protogynous. The anthers possess a similar explosive mechanism to that of Urtica, for the stamens, stretched like watch-springs at first, suddenly burst free, scattering the pollen into the air at the same time.

2549. P. judaica L. (= P. diffusa *Mert. et Koch*, and P. ramiflora *Moench*). (Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.,' pp. 18–19.)—In this species the brush-like stigmas protrude from the bud while the perianth is still closed, and are shrivelled before this opens and the anthers dehisce. Self-pollination is therefore excluded, and crossing with separate stocks always takes place.

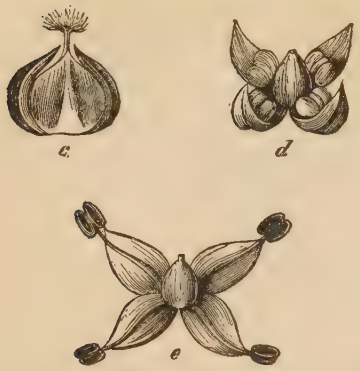


FIG. 362. *Parietaria judaica*, *L.* (after Hildebrand). *c*, Hermaphrodite flower, just before opening; the stigma is already mature. *d*, The same shortly after opening; the stigma has fallen off, but the anthers are still closed. *e*, Flower with dehisced anthers.

2550. P. officinalis L. (= P. erecta *Mert. et Koch*). (Kirchner, 'Beiträge,' p. 12.)—The flower mechanism of this species is the same as that of the preceding one. Some stigmas are red, others white. Warnstorf describes the pollen-grains as very small, white in colour, rounded tetrahedral, 15–18 μ in diameter.

VISITORS.—Redtenbacher observed the Eucnemid beetle Throscus elateroides *Heer*.

790. Pilea Lindl.

2551. P. muscosa Lindl. (= P. microphylla *Liebm.*).—This species is indigenous to tropical America; its flower-buds explode, scattering the pollen into the air in small clouds (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 137).

791. Ficus Tourn.

Dioecious, more rarely monoecious plants, bearing small flowers enclosed in a rounded to pear-shaped fleshy common receptacle closed above (hypanthodium).

2552. F. Carica L. (Linnaeus, 'Amoenitates,' I, p. 41, 1774; St. Laurent, 'Caprificazione,' 1752; Riville, 'Mém. sur la caprification,' 1755; Cavolini, 'Memoria,' 1782; Gallesio, 'Pomona italiana,' 1817; H. Löw, 'Caprifikation,' 1843; Semmola, 'Della caprificazione,' 1845; Gasparrini, Rend. Acc. sc., Napoli, iv, 1845, vii, 1848; Leclerc, 'De la caprification, &c.,' 1858; Delpino, 'Note critiche,' pp. 21–2, 1867; Solms-Laubach, 'D. Herkunft &c. d. gewöhn. Feigenbaumes,' 1882; Hemsley, 'Fig and Caprifig,' 1883; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 157, 161, 540.)—Linnaeus refers to the fact that a special 'messenger of love' (cupido) is necessary for the fertilization of the fig, to transfer the pollen to the female inflorescence; this was known to the ancients, who named the insect 'psen' or 'fig-wasp.' Kerner's account of the process of fertilization by this fig-wasp has already been given in Vol. I of this work (p. 104).

2553. F. Sycomorus L. (= Sycomorus antiquorum *Gasp.*). (Paul Mayer, 'Feigeninsekten.')—This species is also fertilized by means of a small gall-wasp (Sycophaga sycomori *L.*) [Hasselquist] in the same way as the fig by Blastophaga grossorum *Grav.*

Paul Mayer has examined numerous other species of Ficus and Sycomorus (chiefly from herbarium specimens) and found Sycophaga and Blastophaga together in some of them.

792. Cannabis L.

Flowers anemophilous; dioecious.

2554. C. sativa L. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 133, 143; Heyer, 'Untersuchungen, &c.'; Fisch, 'Zahlenverhältnisse'; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—Heyer gives the ratio of male to female plants in this species as 100 : 101–126, but Fisch says that it averages 100 : 154. Kerner states that the anthers of male flowers do not dehisce until 4–5 days after the adjacent female ones open; the wind then shakes the pendulous anthers, and the pollen is scattered; this, however, can only be achieved gradually, the openings being extremely narrow. Warnstorf describes a median streak on each side of each anther provided with adhesive spherules before dehiscence. The pollen-grains are white in colour, tuberculate, irregularly tetrahedral, 31–35 μ in diameter.

793. Humulus L.

Flowers anemophilous; dioecious.

2555. H. Lupulus L. (MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, pp. 374–6; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 133, 143.)—The stigmas of the female flowers of this species are mature at least two days before the anthers of adjacent male stocks dehisce, which they do in the same way as those of Cannabis. Kerner and MacLeod compare the flower mechanism with that of Arrhenatherum elatius and other grasses. Warnstorf (op. cit.) states that the anthers of the male flowers are introrse, and beset externally in the middle line with yellow lupulin granules. The pollen-grains are sulphur-yellow in colour, very irregular, smooth, tetrahedral to polyhedral, about 25 μ in diameter.

794. Morus L.

2556. M. alba L. (Warnstorf, Schr. natw. Ver., Wernigerode, xi, 1896.)—Warnstorf describes this species as anemophilous. The diclinous flowers mature simultaneously. The greenish perianth leaves of the male spikes become reddish on the outside when the pollen is mature. The mealy pollen-grains are white in colour, very irregularly tetrahedral, about 20–5 μ in diameter.

795. Broussonetia L'Hérit.

2557. B. papyrifera Vent. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 137.)—In this species the rather thick filaments lie in the bud like a bent watch-spring, and suddenly straighten when the perianth expands, thus scattering the pollen into the air.

796. Ulmus L.

Anemophilous protogynous flowers with persistent stigmas. Kerner says that shortly before dehiscence of the anthers the filaments elongate to twice their original

length. The anthers open completely in dry weather, but close again when it is damp.

2558. U. montana With. (Kirchner, 'Beiträge,' p. 12; Knuth, 'Bloemenbiol. Bijdragen.')—The two red filiform stigmas in this species are mature when the flowers open, and project beyond the anthers, which are still immature and provided with short filaments. The latter elongate later on, so that the stigmas are hidden among the stamens; the anthers then dehisce, and the stigmas, which are still receptive, may be fertilized by automatic self-pollination if they have not already been dusted with foreign pollen in the first stage of anthesis. The flowers, united in crowded clusters, do not as a rule mature simultaneously, so that blossoms in various stages of maturation are found on the same cluster. Warnstorf describes the pollen-grains as white in colour, irregularly rounded-polyhedral, with uneven undulating ridges, about 30–7 μ in diameter.

Visitors.—Sprengel ('Entd. Geh.,' p. 150) observed the honey-bee, and it is recorded as freq., po-cltg., by Kirchner (Stuttgart), and Knuth (Kiel).

2559. U. campestris L. (Kirchner, op. cit., p. 13; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 311.)—The flower mechanism of this species agrees with that of the preceding one. Kerner says that the stigmas force their way out of the still closed flowers.

Visitors.—Knuth observed the honey-bee, freq., po-cltg.

2560. U. pedunculata Fouger. (= U. effusa *Willd.*, and U. ciliata *Ehrh.*). (Schulz, 'Beiträge.')—The anthers and stigmas in this species mature in the same order as those of the two preceding ones. Schulz describes the perianth as bilaterally symmetrical; and in correspondence with this the anterior style is longer than the other. The two stigmatic branches, partially projecting from the perianth, are beset with a brush-like tuft of long white or reddish papillae, to which the pollen-grains readily adhere. These are yellowish-white in colour, irregularly rounded-polyhedral, beset with ridges, about 30–5 μ in diameter.

797. Celtis Tourn.

2561. C. australis L. (A. Francke, 'Beiträge.')—This South European species is andromonoecious, with protogynous hermaphrodite flowers and earlier maturing male ones.

XCIX. ORDER *PLATANACEAE* LESTIB.

798. Platanus L.

Flowers anemophilous; monoecious. Kerner states that the female flowers mature before the male ones. He also says ('Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 117, 133, 146) that the stamens are claw-shaped, each possessing a shield- or cushion-shaped connective broadening out above the anthers. At the base of the globular, pendulous inflorescence, many of these stamens are crowded together, and their connectives make up a sort of roof. Under this roof are spaces in which the dehisced pollen is stored for a time. As the stamens fall singly from the inflorescence,

openings are made into these spaces through which the pollen falls to be scattered into the air.

Schönland (Bot. Jahrb., Leipzig, iv, 1883, pp. 308–27) states that hermaphrodite flowers occur now and then. He further observed male flowers with reduced carpels, and female ones with reduced stamens, and also entirely neuter flowers.

C. ORDER *JUGLANDACEAE* DC.

799. Juglans L.

Flowers anemophilous; monoecious. Kerner ('Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 94, 119, 133, 148) says that the stiff upright spike, which at an early stage is beset with crowded male flowers, elongates before the beginning of anthesis to such an extent that it hangs over and protects the anthers from above with the bracts and perianth leaves. The stamens being now under cover, the anthers dehisce, and the pollen falls into trough-like depressions on the upper sides of the flowers situated just below. It is removed thence in dry weather by gusts of wind. Warnstorf (Schr. natw. Ver., Wernigerode, xi, 1896) says that the numerous little hairs found on the outside of the perianth and the bracts are much more capable of retaining the pollen. The pollen-grains are whitish in colour, irregularly polyhedral, beset with small tubercles, with obvious germinating processes, up to 50 μ in diameter. Kerner states that the male inflorescences of species of Betula, Corylus, Alnus, and Populus possess the same flower mechanism.

2562. J. regia L.—Delpino and Darwin ('Forms of Flowers') describe the trees as partly protogynous, partly protandrous, and the organs which mature first do so a week before the later ones. Kerner says that the species is protogynous, and the female flowers mature 2–3 days before the male ones.

Delpino ('Ult. oss.,' Atti Soc. ital. sci. nat., Milano, xvii, 1874) states that this is a dimorphous species, not, however, according to the time but to the habitat. Some plants are protogynous in the highest degree, their female flowers maturing about a week before the male; others are equally protandrous, their male flowers maturing the same length of time before the female ones. There is, therefore, a double pollination and fertilization in two periods, the stigmas of the protogynous plants being pollinated and fertilized about eight days before those of the protandrous ones. The pollen of protandrous plants is transferred to the stigmas of protogynous ones by the wind, the stigmas of protandrous plants being dusted with the pollen of protogynous ones by the same means. The numbers of protandrous and protogynous plants are about equal.

2563. J. cinerea L.—Darwin says that the trees of this North American species also are partly protogynous and partly protandrous.

CI. ORDER *MYRICACEAE* RICH.

800. Myrica L.

2564. M. Gale L. (Schulz, Ber. D. bot. Ges., Berlin, xi, 1892, p. 409, foot-note; MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, pp. 128–9.)—Delpino says that

the flowers of this species are generally dioecious, sometimes monoecious, or they may be partially or entirely hermaphrodite.

MacLeod states that the ♂ catkins are more conspicuous than the ♀, the latter having the appearance of immature ♂ ones. Each flower has four stamens proceeding from the base of the catkin-scale, the anthers containing powdery pollen. Each ♀ flower consists of a carpel with 2–4 small scales. As in Potamogeton and Triglochin the pollen is deposited temporarily on the arched catkin-scales, until the wind blows it away in clouds.

CII. ORDER *CUPULIFERAE* RICH.

Flowers monoecious, less often dioecious, and occasionally hermaphrodite; belonging to classes **An** or **Po**.

801. Fagus L.

Flowers anemophilous; monoecious. Kerner says that the trees are protogynous, the female flowers maturing some days earlier than the male.

2565. F. sylvatica L. (MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, pp. 127–8.)—MacLeod states that the flowers in this species mature simultaneously with the foliage leaves. The ♂ flowers are arranged in round, stalked, lateral catkins, and each possesses 8–12 stamens, among which may generally be found the vestige of a pistil. The ♀ flowers grow together in pairs, and each possesses a triangular ovary with three stigmas, and rarely also vestiges of stamens. The ♂ catkins usually possess a flexible stalk, so that they are moved by the wind and the pollen is scattered.

802. Castanea Tourn.

Monoecious pollen-flowers. The male inflorescences are distinguished from the pendulous male catkins of other related genera (Juglans, Quercus, Corylus, Carpinus, &c.) by their erect position.

2566. C. sativa Mill. (= C. vesca *Gaertn.*). (Kirchner, Jahreshefte Ver. Natk., Stuttgart, xlix, 1893, pp. 105–7; Loew, 'Blütenbiol. Floristik,' p. 396; Knuth, 'Bloemenbiol. Bijdragen.')—Kerner describes the male catkins of this species as possessing an aminoid odour. They are very large (up to 20 cm. long), and rather conspicuous, on account of the bright yellow perianth and numerous yellow anthers; they are, therefore, not infrequently visited by insects. Kirchner says that the pollen is not powdery, but tends to cling together. The female flowers are inconspicuous, green in colour, and possess a stiff style with smooth surface and a somewhat sticky stigma.

The flowers of this species are described by Sprengel ('D. Nützlichkeit der Bienen,' p. 7), and also by Delpino ('Ult. oss.,' II, 1870), as anemophilous, but by Kirchner (loc. cit.) as entomophilous pollen-flowers. The male inflorescences are large and directed obliquely upwards; they grow together in such numbers that a tree in bloom is conspicuous from a great distance; the odour is peculiar and quite distinct close at hand, but at some distance it is scarcely noticeable. The inflorescences are about 20 cm. long, crowded with flowers, and, when quite mature,

of a bright yellow colour. In the male flowers, which are very numerous, and enclosed in a bright yellow six-leaved perianth, the stamens are bent inwards at the beginning of anthesis; they straighten out later, each bearing at its upper end a bright yellow anther, which is firmly bound to the filament. When the anthers dehisce, the pollen does not scatter loosely, but remains lying upon them, in consequence of its clinging properties. The pollen-grains are provided with three longitudinal grooves, and often hang together in little clumps, although their extine is smooth and not sticky with clinging drops of oil; when dry, they are 19 μ long and 8 μ thick. There is nothing, therefore, in the structure of the male inflorescence and flowers which points with any probability to anemophily. As regards the female flowers, the inconspicuousness caused by their green colour and the absence of any other means of attraction would certainly indicate wind pollination, if it were not for the fact that the immediate vicinity of the conspicuous fragrant male flowers bearing abundant pollen obviates the necessity for display of colour or any other attraction in the female ones. The structure of styles and stigmas is also quite different from that of an anemophilous plant; the six styles of each flower are strong and stiff, with a smooth shining surface.

The entomophily of Castanea has been confirmed by direct observation. Kirchner saw numerous pollen-collecting honey-bees and many species of flies as well as small beetles visiting the flowers. There is no doubt that these insects, which at first are only concerned with the obtaining of pollen, occasionally reach the female flowers while creeping about the broad inflorescences, and deposit pollen upon them.

Visitors.—The honey-bee was observed by Loew, Kirchner, and Knuth (po-cltg. by the two latter). Kirchner also noticed flies and beetles, and Loew the Alleculid beetle Cteniopus sulphureus *L.* (freq. by Lake Como).

803. Quercus L.

Flowers anemophilous; monoecious. Kerner ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 313) describes the oaks as protogynous, for the female flowers mature some days before the male. Schulz (Ber. D. bot. Ges., Berlin, x, 1892) says that some male flowers possess a fully-developed ovary instead of a vestige. He also observed occasional vestiges of stamens in the female flowers of Q. sessiliflora *Sm.*

2567. Q. sessiliflora Sm., and **2568. Q. Robur** L. (= Q. pedunculata *Ehrh.*). (MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, pp. 126–7.)—MacLeod states that these species possess the following mechanism. The flowers appear simultaneously with the foliage leaves. The thin, loose, interrupted ♂ catkin consists of a flexible axis bearing numerous flowers, each containing 5–8 stamens. The ♀ flowers are arranged in groups of from 1 to 5, crowded in Q. sessiliflora, but more loosely placed in Q. Robur, and consisting of a carpel with three stigmas. The flexible ♂ catkins are set in motion by the wind, and thus scatter the dry, powdery pollen.

804. Corylus L.

2569. C. Avellana L. (Sprengel, 'Entd. Geh.,' p. 432; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 94, 148; Hildebrand, Jahrb. wiss. Bot., Leipzig, ii, 1871;

Kirchner, 'Neue Beob.,' p. 12; Meehan, Bot. Centralbl., Cassel, xvi, 1883, p. 338; MacLeod, op. cit., p. 124; Wehrli, Flora, Marburg, lxxvi, 1892; Loew, 'Blütenbiol. Floristik,' p. 335.)—Several observers (Bail, Baillon, Newdigate, Schulz) have noticed hermaphrodite as well as unisexual flowers in this species. Hildebrand states that only young trees bear flowers, but according to Kirchner this is not always the case. Meehan says that if the spring is warm the ♂ flowers scatter their pollen before the ♀ ones are fully mature; if cold, however, the stocks are homogamous. In the first case few fruits are set, but in the latter they are abundant.

Kerner asserts that pollen is only scattered in dry windy weather; in other circumstances it is stored inside the flower in a place sheltered from the rain. Alnus, Betula, Populus, and Carpinus agree in this respect.

Stocks may be homogamous, protogynous, or protandrous, in different places. Kirchner found they were usually homogamous at Stuttgart, but the stigmas were still receptive after the anthers had dehisced; he also observed rare protandry. Kerner describes the stocks as protogynous. MacLeod found them to be homogamous in Flanders. Those which I examined in Kiel were protogynous to such an extent that in some circumstances the interval between the maturation of the two sexes might last a week (*cf.* Vol. I, p. 43). Wehrli observed a bush near Aarau, which for two consecutive years bore only female flowers instead of male catkins, and corresponded completely to the latter, except that the four stamens were replaced by four stigmas, while ovaries were absent. Warnstorf describes the pollen-grains as sulphur-yellow in colour when examined in the mass, tetrahedral, smooth, about 31 μ in diameter, with three germinating processes.

Visitors (to ♂ catkins).—Herm. Müller (Lippstadt, 'Fertilisation,' p. 523) and Knuth (Kiel) observed the honey-bee. Burkill (Yorkshire coast) noticed the Syrphid Melanostoma quadrimaculata *Verral* ♂ and ♀, po-dvg. ('Fertilisation of Spring Flowers').

805. Carpinus L.

Flowers anemophilous; monoecious; the ♂ bearing numerous stamens and the ♀ arranged in loose spikes.

2570. C. Betulus L. (Sprengel, 'Entd. Geh.,' p. 431; Kerner, loc. cit.; Warnstorf, Schr. natw. Ver., Wernigerode, xi, 1896; MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, pp. 125–6.)—The ♂ flowers of this species are arranged in pendulous spikes, the anthers borne on a connective with two arms of equal length, extrorse, partially brownish-red in colour, possessing a long apical tuft of white hairs. The pollen-grains are whitish-yellow in colour, irregularly polyhedral, tuberculate, on an average 50 μ in diameter. MacLeod says that the ♂ and ♀ catkins appear at the same time as the leaves. The ♀ are situated above the ♂, but this is reversed in the case of Betula and Alnus.

806. Betula L.

Flowers anemophilous; monoecious; occasionally hermaphrodite; rarely dioecious. Kerner describes the plants as protogynous, the female flowers maturing earlier than the male ones of the same stock.

2571. B. alba L. (= B. verrucosa *Ehrh.*). (MacLeod, op. cit., pp. 119–21;

Kerner, loc. cit.; Schulz, Ber. D. bot. Ges., Berlin, x, 1892; von Wettstein, Verh. Zool.-Bot. Ges., Wien, xl, 1890, pp. 68–79.)—MacLeod says that the ♂ catkins of this species are larger than the ♀, the latter possessing a more flexible axis than the former. Schulz observed occasional hermaphrodite flowers, and von Wettstein found entirely male and entirely female specimens.

2572. B. pubescens Ehrh. (= B. alba *L.*, according to the *Index Kewensis*).—As the preceding species.

2573. B. nana L. (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' p. 77; Andersson u. Hesselman, 'Bidrag till Känned. om Spetsbergens o. Beeren Eil. Kärlväxtflora,' p. 667.)—Vanhöffen (*cf.* Abromeit, loc. cit.) describes the dwarf birch as being among the less fragrant plants of Greenland. In Spitzbergen (23. 7. '98) it was found growing, and bearing numerous ♂ and ♀ catkins, in a low sheltered branch of Advent Bay Valley. A specimen collected by Björling (26. 7. '90) possessed well-developed but seedless fruits (*cf.* Andersson and Hesselman, loc. cit.).

807. Alnus L.

Flowers anemophilous; monoecious; sometimes hermaphrodite.

2574. A. glutinosa Medic. (Bail, Bot. Ztg., Leipzig, xxviii, 1870; Schulz, Ber. D. bot. Ges., Berlin, x, 1892; Kerner, loc. cit.; Kirchner, 'Neue Beob.'; MacLeod, op. cit., pp. 121–3.)—Bail and Schulz state that hermaphrodite flowers are not rare in this species; they are at least much more frequent than in Betula. Kirchner describes the stocks as protandrous, the stigmas not maturing until the ♂ flowers have withered. Kerner, however, says that they are protogynous, the ♀ flowers maturing before the ♂. MacLeod states that the ♂ and ♀ catkins mature simultaneously, and appear before the leaves. The ♂ catkin possesses a long flexibl axis, which can be set in motion by the wind; this bears the flowers in groups of three. The ♀ catkins are much smaller, the flowers being arranged in pairs. Warnstorf describes the pollen-grains as pale yellow in colour, decahedral with blunt angles, 31 μ in diameter, smooth, with five germinating processes.

2575. A. viridis DC.—Kerner states that the ♀ flowers of this species mature 4–5 days earlier than the ♂ ones on the same plant.

CIII. ORDER *SALICINEAE* RICH.

808. Salix L.

Literature.—Sprengel, 'Entd. Geh.,' pp. 437–8; Herm. Müller, 'Fertilisation,' pp. 524–6; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 313–14; MacLeod, Bot. Jaarb. Dodonaea, Ghent, vi, 1894, pp. 128–9; Knuth, 'Grundriss d. Blütenbiol.'; Heinricher, Sitz.-Ber. Ak. Wiss., Wien, lxxxvii, 1883.

Flowers entomophilous; dioecious; with half-concealed nectar. The mechanism of willows is the simplest found among insect-pollinated forms. Although the flowers are insignificant they are rendered conspicuous by being aggregated into catkins, especially as these generally appear before the leaves unfold. Both the more conspicuous ♂ flowers (which are therefore the first to be visited by insects), and the ♀,

secrete abundant nectar; they are consequently much sought by numerous insects, particularly bees, which bring about cross-pollination and also lead to the formation of the numerous hybrids.

Kerner states that the ♀ flowers of many species (e.g. S. fragilis *L.*, S. viminalis *L.*, S. triandra *L.*, and S. purpurea *L.*) mature earlier than the ♂ flowers of adjacent trees. Jordan says that the anthers turn their pollen-covered surfaces towards the side in such a way that the proboscis of an insect inserted between the stamens to suck nectar must be thickly dusted with pollen. Heinricher, von Seemen, and others observed androgynous inflorescences.

One of three androgynous inflorescences of S. Caprea *L.* examined by Heinricher bore mixed ♂ and ♀ flowers at the base, and only ♂ on the upper half; the second bore only ♀ at the base, only ♂ at the top, and both ♂ and ♀ in the middle; the third bore only ☿ flowers.

As insect visitors go from one species of willow to another indiscriminately, it is difficult to assign them to individual species. In the following lists, therefore, the visitors of various species are often grouped together, as was done by Hermann Müller.

2576. S. cinerea L.; **2577. S. Caprea** L.; **2578. S. aurita** L., and others. (Herm. Müller, 'Fertilisation,' pp. 524–5, 'Weit. Beob.,' II, pp. 210–11; Knuth, 'Bloemenbiol. Bijdragen.')—

Visitors.—Burkill observed the following on the Yorkshire coast ('Fertilisation of Spring Flowers').—

A. Diptera. (*a*) *Muscidae*: 1. Scatophaga stercoraria *L.*, on ♂ and ♀ catkins, skg. (*b*) *Stratiomyidae*: 2. Lasiopa sp., as 1. po-cltg. (*c*) *Syrphidae*: 3. Eristalis arbustorum *L.*, on ♂ catkins; 4. Melanostoma quadrimaculata *Verral*, on ♀ catkins, skg. **B. Hymenoptera.** *Apidae*: 5. Andrena gwynana *K.*, on ♂ catkins, skg. and po-cltg.; 6. Apis mellifica *L.*, on ♂ and ♀ catkins, very common, skg.; 7. Bombus agrorum *F.*, on ♂ catkins, skg.; 8. B. terrester *L.*, on ♂ and ♀ catkins, skg.

Krieger observed the following bees on S. Caprea at Leipzig.—

Apidae: 1. Andrena albicans *Müll.*; 2. A. cineraria *L.* a ♂; 3. A. eximia *Sm.*; 4. A. extricata *Sm.*; 5. A. flavipes *Pz.*; 6. A. gwynana *K.*; 7. A. nitida *Fourcr.*; 8. A. ovina *Klug.*; 9. A. parvula *K.*; 10. A. tibialis *K.*; 11. Bombus derhamellus *K.* ♀ (= B. rajellus *K.*); 12. B. hortorum *L.* ♀; 13. B. terrester *L.*; 14. Colletes cunicularius *L.*; 15. Halictus calceatus *Scop.* (= H. cylindricus *F.*); 16. H. levis *Ths.* ♀; 17. H. nitidiusculus *K.*; 18. Nomada lineola *Pz.*; 19. Osmia rufa *L.* ♂; 20. Podalirius acervorum *L.* ♂, freq.; 21. Psithyrus quadricolor *Lep.* a ♀.

Herm. Müller gives the following list for the 3 species.—

A. Coleoptera. (*a*) *Elateridae*: 1. Corymbites castaneus *L.*; 2. Limonius parvulus *Pz.* (*b*) *Nitidulidae*; 3. Meligethes sp., freq., nect-lkg. **B. Diptera.** (*a*) *Bibionidae*: 4. Bibio johannis *L.*, skg.; 5. B. marci *L.*, do.; 6. Dilophus vulgaris *Mg.*, freq. (*b*) *Bombyliidae*: 7. Bombylius major *L.*, skg. (*c*) *Conopidae*: 8. Myopa buccata *L.*, not infreq., skg.; 9. M. testacea *L.*, do.; 10. Sicus ferrugineus *L.*, do. (*d*) *Empidae*: 11. Empis sp., freq., skg.; 12. Rhamphomyia sulcata *Fall.*, skg. (*e*) *Muscidae*: 13. Calliphora erythrocephala *Mg.*, skg.; 14. Exorista sp.; 15. Gonia ornata *Mg.*, skg.; 16. Pollenia rudis *F.*, po-dvg.; 17. P. vespillo *F.*, skg. and po-dvg.; 18. Scatophaga merdaria *L.*, freq., skg.; 19. S. stercoraria *L.*, do. (*f*) *Syrphidae*: 20. Brachypalpus valgus *Pz.*, skg. and po-dvg.; 21. Cheilosia brachysoma *Egg.*, do.; 22. C. chloris *Mg.*, do.; 23. C. modesta *Egg.*, do.;

24. C. pictipennis *Egg.*, do.; 25. C. praecox *Zett.*, do.; 26. C. urbana *Mg.*, do.; 27. Eristalis aeneus *Scop.*, do.; 28. E. arbustorum *L.*, do.; 29. E. intricarius *L.*, do.; 30. E. pertinax, *Scop.*, do.; 31. E. tenax *L.*, do.; 32. Syritta pipiens, *L.*, do.; 33. Syrphus balteatus *Deg.*, do.; 34. S. corollae *F.*, do.; 35. S. pyrastri *L.*, do.; 36. S. ribesii *L.*, do. **C. Hemiptera.** 37. Anthocoris sp., skg. **D. Hymenoptera.** (*a*) *Apidae*: 38. Andrena albicans *Müll.* ♀ and ♂, exceedingly common; 39. A. albicrus *K.* ♀ and ♂; 40. A. apicata *Sm.* ♀; 41. A. argentata *Sm.* (= A. gracilis *Schenck*) ♀ rare, ♂ freq.; 42. A. atriceps *K.* (= A. tibialis *K.*) ♀ and ♂; 43. A. chrysosceles *K.* ♂; 44. A. cineraria *L.* ♀ and ♂, freq.; 45. A. collinsonana *K.* ♀; 46. A. connectens *K.* ♀, rare; 47. A. dorsata *K.* ♀ and ♂, freq.; 48. A. eximia *Sm.* ♀; 49. A. fasciata *Wesm.* ♂; 50. A. flessae *Pz.* ♀; 51. A. fulva *Schr.* ♂, N.B.; 52. A. fulvicrus *K.* ♀ and ♂, freq.; 53. A. fulvida *Schenck* ♀; 54. A. gwynana *K.* ♀ and ♂, do.; 55. A. helvola *L.* ♀ and ♂; 56. A. nigroaenea *K.* ♀ and ♂; 57. A. nitida *Fourcr.* ♂; 58. A. parvula *K.* ♀ and ♂, freq.; 59. A. pilipes *F.* ♂; 60. A. pratensis *Nyl.* (= A. ovina *Kl.*) ♀ and ♂; 61. A. floricola *Ev.* ♀ and ♂; 62. A. ruficrus *Nyl.* ♀ and ♂, skg. and po-cltg.; 63. A. schrankella *Nyl.* ♀; 64. A. smithella *K.* ♂ very common, ♀ more rare; 65. A. trimmerana *K.* ♀; 66. A. varians *Rossi* ♀; 67. A. ventralis *Imh.* ♂ very common, ♀ rare; in all Andrenae, ♂ skg., ♀ po-cltg. and skg.; 68. Apis mellifica *L.* ☿, skg. and po-cltg.; 69. Bombus distinguendus *Mor.* ♀; 70. B. hortorum *L.* ♀; 71. B. lapidarius *L.* ♀; 72. B. pratorum *L.* ♀; 73. B. scrimshiranus *K.* ♀; 74. B. terrester *L.* ♀, all skg.; 75. Colletes cunicularius *L.* ♀, very numerous; 76. Halictus albipes *F.* ♀, skg.; 77. H. cylindricus *F.* ♀, do.; 78. H. flavipes *F.* ♀, skg. and po-cltg.; 79. H. malachurus *K.* ♀; 80. H. minutus *K.* ♀; 81. H. sexstrigatus *Schenck* ♀, skg. and po-cltg.; 82. Nomada fabriciana *L.* ♂ (= N. notata *K.*), skg.; 83. N. furva *Pz.* (= N. minuta *F.*) ♂, skg.; 84. N. lateralis *Pz.* ♀ and ♂, skg.; 85. N. lathburiana *K.* ♀ and ♂, freq.; 86. N. lineola *Pz.* ♂; 87. N. alboguttata *H.-Sch.*, var. pallescens *H.-Sch.*, skg.; 88. N. ruficornis *L.* ♀ and ♂, very common; 89. N. ruficornis *L.*, var. signata *Jur.*, skg.; 90. N. succincta *Pz.* ♀ and ♂, very common; 91. Osmia rufa *L.* ♂, skg.; 92. Psithyrus vestalis *Fourcr.* ♀, skg.; 93. Sphecodes gibbus *L.* ♀, and varieties, skg. (*b*) *Formicidae*: 94. Lasius fuliginosus *Ltr.* ☿, nect-lkg. (*c*) *Ichneumonidae*: 95. Several sp. (*d*) *Pteromalidae*: 96. Perilampus sp., in large numbers. (*e*) *Tenthredinidae*: 97. Dolerus pratensis *L.*, skg.; 98. D. gonager *F.*, do.; 99. D. madidus *Klg.*, do.; 100. Amauronematus histrio *Lep.*, do. (*f*) *Vespidae*: 101. Odynerus parietum *L.* ♀, do.; 102. Vespa germanica *F.* ♀, do. **E. Lepidoptera.** (*a*) *Tineidae*: 103. Adela cuprella *Thbg.* ♂ and ♀ (Borgstette, Tecklenburg); 104. A. sp., freq. (*b*) *Rhopalocera*: 105. Lycaena argiolus *L.*, skg.; 106. Vanessa urticae *L.*, freq., do.

Loew (Brandenberg) observed the following in S. Caprea ('Beiträge,' p. 38).—

A. Diptera. *Muscidae*: 1. Scatophaga stercoraria *L.* **B. Hymenoptera.** *Apidae*: 2. Andrena albicans *Müll.* ♂, skg.; 3. A. fulva *Schr.* ♀, skg.; 4. A. fulvicrus *K.* ♀ and ♂; 5. A. morawitzi *Ths.* ♂; 6. A. nigroaenea *K.* ♂, skg.; 7. A. ovina *Klg.* ♀, skg.; 8. A. pilipes *F.* ♂, skg.; 9. A. praecox *Scop.* ♀, skg.; 10. A. trimmerana *K.* ♂; 11. Apis mellifica *L.* ☿, skg.; 12. Bombus terrester *L.* ♀, skg.; 13. Colletes cunicularius *L.* ♂ and ♀, skg.; 14. Halictus cylindricus *F.* ♀, do.; 15. Nomada lineola *Pz.* ♂, do.; 16. Osmia bicornis *L.* ♂, also (Berlin Botanic Garden), Apis, skg.

Burkill gives the following for S. Caprea on the Yorkshire coast ('Fertlsn. of Spring Fls.').—

A. Acarina. 1. A small sp., creeping over the ♂ catkins. **B. Diptera.** (*a*) *Bibionidae*: 2. Scatopse notata *L.*, on ♀ and ♂ catkins. (*b*) *Empidae*: 3. Empis sp., on ♀ catkins. (*c*) *Muscidae*: 4. Actora aestuum *Mg.*, on ♀ and ♂ catkins; 5. Calliphora erythrocephala *Mg.*, on ♀ catkins; 6. Lucilia cornicina *F.*, on ♀ and ♂ catkins; 7. Phorbia muscaria *Mg.*, do.; 8. P. sp., do.; 9. Pollenia rudis *F.*, do.; 10. Scatophaga stercoraria *L.*, on ♂ catkins; 11. Sepsis nigripes *Mg.*, on ♀

catkins; 12. One other small Muscid, do. (*d*) *Stratiomyidae*: 13. Lasiopa sp., on ♀ and ♂ catkins. (*e*) *Syrphidae*: 14. Eristalis pertinax *Scop.*, on ♂ and ♀ catkins, skg.; 15. Melanostoma quadrimaculata *Verral*, do. **C. Hymenoptera.** (*a*) *Apidae*: 16. Andrena clarkella *K.* ♂, on ♀ catkins; 17. A. gwynana *K.* ♀, on ♂ and ♀ catkins, po-cltg.; 18. Apis mellifica *L.* ☿, do. ♂; 19. Bombus hortorum *L.*, do. ♂; 20. B. terrester *L.*, do., ♀ freq., skg. and po-cltg. (*b*) *Ichneumonidae*: 21. Ichneumon sp., upon ♀ and ♂ catkins. **D. Lepidoptera.** *Rhopalocera*: 22. Vanessa urticae *L.*, on ♂ and ♀ catkins, skg.

The following were recorded by the observers, and for the localities stated.—

Knuth (on S. amita), a skg. Muscid (Scatophaga stercoraria *L.*) and 2 skg. and po-cltg. bees (Apis, and Bombus terrester *L.* ♀ and ☿). Loew (Brandenburg, 'Beiträge,' p. 38), a Muscid (Conia capitata *Deg.*) and a Syrphid (Syrphus lunulatus *Mg.*, skg.); (Berlin Botanic Garden) Apis, skg. Schmiedeknecht (Thuringia), 9 bees—1. Andrena congruens *Schmiedekn.*; 2. A. dubitata *Schenck*; 3. A. extricata *Sm.*; 4. A. pilipes *F.* (= A. carbonaria *L.*); 5. A. eximia *Sm.*; 6. A. albicans *Müll.*; 7. A. albicrus *K.*; 8. A. tibialis *K.*; 9. Bombus lapidarius *L.*, a ♀. Scott-Elliot (Dumfriesshire), a humble-bee and an Empid (freq.) ('Flora of Dumfriesshire,' p. 157). Schenck (Nassau), 6 bees—1. Andrena apicata *Sm.* ♀; 2. A. clarkella *K.*; 3. A. gwynana *K.*; 4. A. trimmerana *K.*; 5. Nomada fabriciana *L.*; 6. N. lineola *Pz.* Friese (Fiume), 2 bees—1. Andrena clarkella *K.*, and 2. A. morawitzi *Ths.*, var. paveli *Mocs.*

S. cinerea *L.* (Warnstorf, Schr. natw. Ver., Wernigerode, xi. 1896.)—Warnstorf describes the pollen-grains in this species as dark-yellow, ellipsoidal, closely tuberculate, on an average 30–5 μ long, and 17 μ broad.

The following were recorded by the observers, and for the localities stated.—

Alfken (Bremen), 9 bees—1. Andrena apicata *Sm.* ♀ and ♂; 2. A. clarkella *K.* ♀ and ♂; 3. A. nigroaenea *K.* ♀ and ♂; 4. A. trimmerana *K.* ♀ and ♂; 5. Bombus jonellus *K.* ♀; 6. B. terrester *L.* ♀; 7. Nomada lineola *Pz.* ♂; 8. N. ruficornis *L.* ♀ and ♂; 9. N. succincta *Pz.* ♀ and ♂, skg. Friese (Mecklenburg), 7 bees—1. Andrena apicata *Sm.*; 2. A. morawitzi *Ths.* ♀, not infreq., po-cltg., var. paveli *Mocs.*, rare (also in Hungary); 3. A. praecox *Scop.*; 4. A. albicrus *K.*; 5. A. nigroaenea *K.*; 6. A. tibialis *K.* (also Fiume); 7. A. lucens *Imh.* Loew (Berlin Botanic Garden), 2 bees—1. Andrena albicans *Müll.* ♂, skg.; and 2. Apis mellifica *L.* ☿, do.; on S. cinerea *L.* × S. purpurea *L.* (♀), S. cinerea *L.* × S. nigricans *Sm.* (♀), and S. Caprea *L.* × S. silesiaca *Willd.* (♂), the honey-bee; on S. aurita *L.* × S. purpurea *L.*, the honey-bee Bombus terrester *L.* ♀, skg.

2579. S. alba L.—

Visitors.—Alfken observed the following on S. alba, S. fragilis, and other sp. at Bremen.—

A. Diptera. (*a*) *Bibionidae*: 1. Bibio marci *L.* (*b*) *Bombyliidae*: 2. Bombylius major *L.* (*c*) *Conopidae*: 3. Myopa buccata *L.*; 4. M. polystigma *Rond.*; 5. M. testacea *L.* (*d*) *Muscidae*: 6. Gonia fasciata *Mg.*; 7. G. ornata *Mg.*; 8. Musca domestica *L.*; 9. Pollenia rudis *F.*; 10. Scatophaga stercoraria *L.* (*e*) *Syrphidae*: 11. Brachypalpus valgus *Pz.*; 12. Cheilosia flavicornis *F.*; 13. C. praecox *Zett.*; 14. Eristalis intricarius *L.*; 15. E. sepulcralis *L.*; 16. Platycheirus albimanus *F.*; 17. Syrphus pyastri *L.* **B. Hymenoptera.** (*a*) *Apidae*: 18. Andrena albicans *Müll.* ♀ and ♂; 19. A. albicrus *K.* ♀ and ♂; 20. A. apicata *Sm.* ♀ and ♂; 21. A. argentata *Sm.* ♀ and ♂; 22. A. carbonaria *L.* ♀ and ♂; 23. A. chrysosceles *K.* ♀ and ♂; 24. A. cineraria *L.* ♀ and ♂; 25. A. clarkella *K.* ♀ and ♂; 26. A. convexiuscula *K.* ♀ and ♂; 27. A. eximia *Sm.* ♀ and ♂; 28. A. extricata *Sm.* ♀ and ♂; 29. A. flavipes *Pz.* ♀ and ♂; 30. A. gwynana *K.* ♀ and ♂; 31. A. lapponica *Zett.* ♂; 32. A. morawitzi

Ths. ♀ and ♂; 33. A. nigroaenea *K.* ♀ and ♂; 34. A. nitida *Fourcr.* ♀ and ♂; 35. A. ovina *Klg.* ♀ and ♂; 36. A. parvula *K.* ♀ and ♂; 37. A. praecox *Scop.* ♀ and ♂; 38. A. propinqua *Schenck* ♀ and ♂; 39. A. rufitarsis *Zett.* ♀ and ♂; 40. A. thoracica *F.* ♀ and ♂; 41. A. tibialis *K.* ♀ and ♂; 42. A. trimmerana *K.* ♀ and ♂; 43. A. varians *K.* ♀ and ♂; 44. A. xanthura *K.* ♀ and ♂, stylopized, only skg.; 45. Bombus derhamellus *K.* ♀; 46. B. jonellus *K.* ♀; 47. B. lapidarius *L.* ♀; 48. B. lucorum *L.* ♀; 49. B. muscorum *F.* ♀; 50. B. terrester *L.* ♀; 51. Colletus cunicularius *L.* ♀ and ♂; 52. Halictus brevicornis *Schenck* ♀; 53. H. calceatus *Scop.*, var. elegans *Lep.* ♀; 54. H. flavipes *F.* ♀; 55. H. levis *K. Ths.* ♀; 56. H. minutus *K.* ♀; 57. H. morio *F.* ♀; 58. H. nitidiusculus *K.* ♀; 59. H. quadrinotatulus *Schenck* ♀; 60. H. rubicundus *Chr.* ♀; 61. Nomada alboguttata *H.-Sch.* ♀ and ♂; 62. N. alternata *K.* ♀ and ♂; 63. N. bifida *Ths.* ♀ and ♂; 64. N. borealis *Zett.* ♀ and ♂; 65. N. fabriciana *L.* ♀ and ♂; 66. N. fucata *Pz.* ♀ and ♂; 67. N. lathburiana *K.* ♀ and ♂; 68. N. lineola *Pz.* ♀ and ♂; 69. N. obscura *Zett.* ♀; 70. N. ruficornis *L.* ♀ and ♂; 71. N. succincta *Pz.* ♀ and ♂, skg.; 72. N. xanthosticta *K.* ♀ and ♂, do.; 73. Osmia connuta *Ltr.* ♂; 74. O. rufa *L.* ♀ and ♂; 75. Podalirius acervorum *L.* ♂; 76. Psithyrus vestalis *Fourcr.* ♀, freq. (*b*) *Ichneumonidae*: 77. Banchus falcator *F.*, skg.; 78. Ichneumon sarcitorius *L.* ♀, skg.; 79. I. suspiciosus *Westm.* ♀, skg. (*c*) *Tenthredinidae*: 80. Amauronematus fahraei *Ths.*; 81. A. viduatus *Zett.*; 82. A. vittatus *Lep.*; 83. Dolerus coruscans *Knw.*; 84. D. fissus *Htg.*; 85. D. fumosus *Zadd.*; 86. D. gonager *F.*; 87. D. haematodis *Schr.*; 88. D. madidus *Klg.*; 89. D. puncticollis *Ths.*; 90. D. rugosus *Knw.* (= D. rugosulus *D. T.*); 91. Tomostethus fuliginosus *Schr.*; 92. Pteronus brevivalvis *Ths.* (*d*) *Vespidae*: 93. Vespa callosus *Ths.* ♀; 94. V. crabro *L.* ♀.

The following were recorded by the observers, and for the localities stated.—

Loew (Brandenburg), the Bibionid Bibio marci *L.* ♂ and ♀, skg. Schletterer and von Dalla Torre (Tyrol), the bee Andrena praecox *Scop.* ♂. Friese (Saalthal), the saw-fly Amauronematus histrio *Lep.*

2580. S. fragilis L. (Seemen, Öst. bot. Ztg., Wien, xlv, 1895; Herm. Müller, 'Weit. Beob.,' I, p. 211.)—Seemen and many others observed very varied abnormal flower-forms on this and other species of willow, from which it may be concluded that these plants possess great capacity and tendency to vary their flowers, by increase or decrease of stamens or carpels, by the substitution of organs of one sex by those of another, by transition forms from one sex to another, and so on.

Visitors.—Herm. Müller observed the following at Jena.—

A. Coleoptera. (*a*) *Nitidulidae*: 1. Meligethes sp., nect-lkg. (*b*) *Oedemeridae*: 2. Oedemera coerulea *L.*, nect-lkg. **B. Hymenoptera.** (*a*) *Apidae*: 3. Andrena parvula *K.* ♀, skg. and po-dvg.; 4. Apis mellifica *L.* ☿, do.; 5. Halictus maculatus *Sm.* ♀, do. (*b*) *Formicidae*: 6. Formica rufa *L.* ☿, nect-lkg.

2581. S. triandra L. (= S. amygdalina *L.*).—

Visitors.—The following were recorded by the observers, and for the localities stated.—

Loew (Brandenburg, 'Beiträge,' p. 38), the bee Andrena albicans *Müll.* ♀, skg. Herm. Müller ('Weit. Beob.,' II, p. 211).—**A. Diptera.** (*a*) *Bibionidae*: 1. Dilophus vulgaris *Mg.* ♀ and ♂, freq. (*b*) *Empidae*: 2. Empis opaca *F.*, skg. **B. Hymenoptera.** *Apidae*: 3. Andrena albicrus *K.* ☿, skg.; 4. A. sp., do.; 5. Apis mellifica *L.* ☿, numerous, skg. and po-dvg. Friese (Saalthal), the bee Andrena ventralis *Imh.* Alfken (Bremen), 3 bees—1. Andrena albicrus *K.* ♀; 2. Halictus rubicundus *Chr.* ♀; 3. H. quadrinotatulus *Schenck* ♀, skg. Frey (Switzerland), the Bombycid Pygaera anastomosis *L.*

2582. S. pentandra L.—

Visitors.—Schmiedeknecht observed the bee Andrena eximia *Sm.* in Thuringia.

2583. S. viminalis L.—

Visitors.—Burkill observed the following on the Yorkshire coast ('Fertlsn. of Spring Fls.').—

A. Diptera. (*a*) *Muscidae*: 1. Actora aestuum *Mg.*, on ♀ catkins; 2. Onesia cognata *Mg.*, do.; 3. Helozyma sp., do.; 4. Hylemyia sp., do.; 5. Scatophaga stercoraria *L.*, do.; 6. Simulia sp., do.; 7. Tephrochlamys rufiventris *Mg.*, do.; 8. One other Muscid, do. (*b*) *Rhyphidae*: 9. Rhyphus fenestralis *Scop.*, on ♀ catkins. (*c*) *Stratiomyidae*: 10. Lasiopa sp., do. (*d*) *Syrphidae*: 11. Melanostoma quadrimaculata *Verral*, on ♀ catkins; 12. Syrphus lasiophthalmus *Zett.*, do. **B. Hemiptera.** 13. One sp., on ♀ catkins. **C. Hymenoptera.** (*a*) *Apidae*: 14. Andrena clarkella *K.* ♂, on ♀ catkins. (*b*) *Ichneumonidae*: 15. Ichneumon sp., on ♀ catkins.

Alfken records 17 bees for Bremen.—

Apidae: 1. Andrena albicans *Müll.*; 2. A. albicrus *K.*; 3. A. chrysosceles *K.*; 4. A. cineraria *L.*; 5. A. extricata *Sm.*; 6. A. fulvicrus *K.*; 7. A. nitida *Fourcr.*; 8. A. ovina *Klug.*; 9. A. praecox *Scop.*; 10. Bombus agrorum *F.* ♀; 11. B. pratorum *L.* ♀; 12. B. terrester *L.* ♀; 13. Colletes cunicularius *L.* ♀ skg. and po-cltg., ♂ skg.; 14. Halictus calceatus *Scop.*; 15. H. flavipes *F.*; 16. Nomada alternata *K.* ♂; 17. N. bifida *Thoms.* ♀ and ♂.

The following were recorded by the observers, and for the localities stated.—

Friese (Mecklenburg), 3 bees—1. Andrena morawitzi *Ths.* ♀ po-cltg., and ♂; 2. A. praecox *Scop.*, do.; 3. A. propinqua *Schenck*, do. Schmiedeknecht (Thuringia), the parasitic bee Nomada bifida *Ths.*

2584. S. purpurea L.—

Visitors.—Burkill gives the following list for the Yorkshire coast ('Fertlsn. of Spring Fls.').—

A. Coleoptera. *Staphylinidae*: 1. Tachyporus hypnorum *F.*, on ♂ catkins. **B. Diptera.** (*a*) *Muscidae*: 2. Actora aestuum *Mg.*, on ♂ catkins; 3. Hylemyia sp., do.; 4. Limnophora septemnotata *Ztt.*, do.; 5. Phorbia sp., do.; 6. Drosophila graminum *Fall.*, do.; 7. Scatophaga stercoraria *L.*, on ♂ and ♀ catkins, skg.; 8. Sepsis nigripes *Mg.*, on ♂ catkins; 9. Undetermined sp., on ♀ catkins; 10. Three other small flies, on ♂ catkins. (*b*) *Syrphidae*: 11. Eristalis pertinax *Scop.*, on ♂ catkins; 12. Melanostoma quadrimaculata *Verral*, do. **C. Hymenoptera.** *Apidae*: 13. Andrena gwynana *K.* ♀, on ♂ catkins.

The following were recorded by the observers, and for the localities stated.—

Schenck (Nassau), 2 bees—1. Andrena clarkella *K.*, and 2. A. eximia *Sm.* Alfken (Bremen), the bee Andrena chrysosceles *K.* ♀. Schmiedeknecht (Thuringia), a bee (Andrena eximia *Sm.*) and a humble-bee (Bombus hypnorum *L.* ♀). Ducke (Trieste), the bee Andrena (Biareolina) neglecta *Dours.*

2585. S. arctica Pall.—Vanhöffen collected in Greenland several forms of the sub-species B. greenlandica *Anders.*, and found them to possess clearly developed nectaries of elongated linear form, a red to dull-red style over one mm. long, and spreading stigmas, simple or divided. Ripe fruits were several times observed (*cf.* Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.').

Visitors.—Ekstam observed medium-sized flies in Nova Zemlia.

2586. S. incana Schrank.—

Visitors.—Schiner observed the hover-fly Criorhina ruficauda *Deg.* in Austria.

2587. S. nigricans Sm.

Visitors.—Friese observed the following 65 bees on species of Salix in Alsace (A.), Baden (B.), Fiume (F.), Hungary (H.), Mecklenburg (M.), and Trieste (T.).—

1. Andrena albicans *Müll.* (A., B.) not infreq., (H., M.) very common ; 2. Albicrus *K.* (M.), not infreq.; 3. A. apicata *Sm.* (A., B.) one, (H., M.) not infreq.; 4. A. bimaculata *K.* (M.) one, (F., H., T.) not infreq.; 5. A. bucephala *Steph.* (B.) not infreq.; 6. A. carbonaria *L.* (A.) a ♂; 7. A. cineraria *L.* (H., M.) freq.; 8. A. clarkella *K.* (A.) a ♂, (M.) freq.; 9. A. combinata *Chr.* (B.); 10. A. congruens *Schmiedekn.* (F., H.) freq.; 11. A. convexiuscula *K.* (A., B., M.) freq.; 12. A. croatica *Friese* (F.) freq.; 13. A. dubitata *Schenck* (A.) one, (H.) very common; 14. A. eximia *Sm.* (A., B., H., T.); 15. A. extricata *Sm.* (A., B.) freq.; 16. A. flavipes *Pz.* (M.), freq. (A., B.); 17. A. fulva *Schr.* (B.), one; 18. A. gwynana *K.* (M.) freq., (B.) very common, (A.) more rare, (H.) freq.; 19. A. lucens *Imh.* (F.); 20. A. mitis *Schmiedekn.* (A.) a ♀, (F., H.) not infreq.; 21. A. morawitzi *Ths.* (H.) very rare; 22. A. neglecta *Dours.* (F.) freq.; 23. A. nigroaenea *K.* (M.) freq.; 24. A. nitida *Fourcr.* (B.) rare; 25. A. nycthemera *Imh.* (A.) not infreq., (H.) rare, (M.) freq.; 26. A. ovina *Klug.* (A., B.) one, (M.) not infreq., po-cltg., (H.) very common; 27. A. parviceps *Kriechb.* (H.) freq.; 28. A. parvula *K.* (B.) very common, (M.) freq.; 29. A. paveli *Mocs.* (H.); 30. A. praecox *Scop.* (A.) not infreq., (M.) very common, (H.) freq.; 31. A. propinqua *Schenck* (A.) not infreq.; 32. A. rufula *Pér.* (F., H.); 33. A. sericata *Imh.* (A., B.) rare, (H.) not infreq.; 34. A. spinigera *K.* (=A. dragana *Friese*) (F.) one; 35. A. taraxaci *Cir.* (F., H., T.) not infreq.; 36. A. tibialis *K.* (B.) rare, (A.) freq., (H.) not infreq.; 37. A. trimmerana *K.* (B., H.) freq.; 38. A. tscheki *Mor.* (H.); 39. A. varians *K.* (H.) not infreq., var. helvola *L.* (B.) freq., (H.) not infreq., var. mixta *Schenck* (H.) not infreq.; 40. A. ventralis *Imh.* (A., M.) freq.; 41. Bombus agrorum *F.* ♀ (B.) freq.; 42. B. hypnorum *L.* (B.) a ♀; 43. B. pratorum *L.* ♀ (B.) freq.; 44. B. terrester *L.* ♀ (B.) freq.; 45. Colletes cunicularius *L.* (H., M.) very common; 46. Halictus calceatus *Scop.* (B.) freq.; 47. H. rufocinctus *Nyl.* ♀ (A., B.); 48. H. xanthopus *K.* (A.) a ♀; 49. Megachile muraria *Retz.* (F., H., T.) one; 50. Nomada bifida *Ths.* (B.) not infreq.; 51. N. fabriciana *L.* (B.) a ♂; 52. N. flavoguttata *K.* (M.) one; 53. N. guttulata *Schenck*; 54. N. lathburiana *K.* (E.); 55. N. ruficornis *L.* (B.) freq.; 56. N. succincta *Pz.* (A.) not infreq.; 57. N. trispinosa *Schmiedekn.*; 58. N. xanthosticta *K.* (M.) not freq., (A.) not infreq.; 59. N. zonata *Panz.*; 60. Osmia cornuta *L.* (A.) not infreq.; 61. O. rufa *L.* (B.) freq. (F., H.); 62. Podalirius acervorum *L.*; 63. P. retusus *L.* (A.) a ♂; 64. Sphecodes gibbus *L.* ♀ (A., B.) freq.; 65. Xylocopa violacea *L.* ♀ and ♂ (A.) freq.

Schmiedeknecht gives 16 bees for Thuringia.—

1. Andrena albicans *Müll.*; 2. A. cineraria *L.*; 3. A. nitida *Fourcr.*; 4. A. ovina *Klug.*; 5. A. propinqua *Schenck*; 6. A. thoracica *F.*; 7. A. ventralis *Imh.*; 8. Bombus hypnorum *L.* ♀; 9. B. scrimshiranus *K.* (= B. jonellus *K.*) ♀; 10. B. terrester *L.* ♀; 11. Nomada bifida *Ths.*; 12. N. borealis *Zett.*; 13. N. fabriciana *L.*; 14. N. lateralis *Pz.* (= N. xanthosticta *K.*); 15. N. ruficornis *L.*; 16. Osmia bicornis *L.* (= O. rufa *L.*).

Saunders noticed 21 bees in England.—

1. Andrena albicans *Müll.*; 2. A. apicata *Sm.*; 3. A. bimaculata *K.*; 4. A. carbonaria *L.* (=A. pilipes *F.*); 5. A. cineraria *L.*; 6. A. clarkella *K.*; 7. A. dorsata *K.*; 8. A. flavipes *Pz.* (=A. fulvicrus *K.*); 9. A. fulva *Schr.*; 10. A. gwynana *K.*; 11. A. helvola *L.*; 12. A. minutula *K.* (=A. parvula *K.*); 13. A. nigroaenea *K.*;

14. A. nitida *Fourcr.*; 15. A. praecox *Scop.*; 16. A. rosae *K.* (= A. austriaca *Pz.*); 17. A. thoracica *F.*; 18. A. tibialis *K.*; 19. A. trimmerana *K.*; 20. A. varians *K.*; 21. Colletes cunicularius *L.*

Schenck records 22 bees for Nassau.—

1. Andrena albicans *Müll.*; 2. A. apicata *Sm.*; 3. A. convexiuscula *K.*; 4. A. eximia *Sm.*; 5. A. extricata *Sm.*; 6. A. flavipes *Pz.*; 7. A. gwynana *K.*; 8. A. nigroaenea *K.*; 9. A. nitida *Fourcr.*; 10. A. ovina *Klg.*; 11. A. parvula *K.*; 12. A. praecox *Scop.*; 13. A. tibialis *K.*; 14. Colletes cunicularius *L.*; 15. Halictus calceatus *Scop.* ♀; 16. H. rubicundus *Chr.* ♀; 17. Nomada alternata *K.*; 18. N. ruficornis *L.*, var. flava *Pz.* ♂; 19. N. succincta *Pz.*; 20. Osmia bicolor *Schr.*; 21. O. cornuta *Ltr.*; 22. O. rufa *L.*

The following were recorded by the observers, and for the localities stated.—

Loew (Berlin Botanic Garden), 3 bees—1. Andrena fulva *Schr.* ♀, skg.; 2. Apis mellifica *L.* ☿, do.; 3. Bombus terrester *L.* ♀, do. Wüstnei (Alsen), 7 bees—1. Andrena albicans *Müll.*; 2. A. clarkella *K.*; 3. A. praecox *Scop.*; 4. Bombus scrimshiranus *K.*; 5. B. terrester *L.*; 6. Halictus albipes *F.* ♀; 7. Nomada borealis *Zett.* Frey-Gessner (Switzerland), the bee Andrena humilis *Imh.* Schiner (Austria), 3 hover-flies—1. Cheilosia flavicornis *F.*; 2. Criorhina floccosa *Mg.*; 3. C. oxyacanthae *Mg.* Nylander (Finland), the bee Colletes cunicularius *L.* Zetterstedt (Lapland), the humble-bee Bombus alpinus *L.* Morawitz (St. Petersburg), 3 bees—1. Andrena rufitarsis *Zett.* (= A. ruficrus *Nyl.*); 2. Colletes cunicularius *L.* ♀, po-cltg.; 3. Nomada ruficornis *L.* E. D. Marquard (Cornwall), 2 bees—Andrena spinigera ♂ and Nomada bifida *Ths.* Saunders (Sd.) and Smith (Sm.) (England), 4 bees—1. Andrena apicata *Sm.* (= A. lapponica *Saund.*) (Sd.); 2. A. bimaculata *K.*, 1st gen. (Sd., Sm.); 3. A. combinata *Chr.* (Sm.); 4. A. dorsata *K.* (Sd.). von Dalla Torre (Tyrol), 7 bees—1. Andrena atriceps *K.* ♂; 2. A. nitida *K.* ♂; 3. A. ovina *Klg.* ♂; 4. A. rosae *Pz.* ♂; 5. Anthophora pilipes *F.* ♂ (Pr. R.); 6. Osmia cornuta *Ltr.* ♂; 7. Sphecodes rufescens *Fourcr.* (= S. ephippius *L.*). Schletterer (Tyrol), 5 bees—1. Andrena austriaca *Pz.*; 2. A. ovina *Klg.*; 3. A. tibialis *K.*; 4. Osmia cornuta *Ltr.*; 5. Podalirius acervorum *L.* Hoffer (Steiermark), the carpenter-bee Xylocopa violacea *L.* ♂. Ducke (Trieste), 3 bees—1. Andrena dubitata *Schenck* ♀ and ♂; 2. A. mitis *Pér.* ♀ and ♂; 3. A. spinigera *K.* ♂.

2588. S. repens L. (Herm. Müller, 'Fertilisation,' p. 526; Knuth, 'Bloemenbiol. Bijdragen.')—

Visitors.—Herm. Müller gives the following list.—

A. Diptera. (*a*) *Bombyliidae*: 1. Bombylius major *L.*, skg. (*b*) *Conopidae*: 2. Myopa buccata *L.*, skg. **B. Hymenoptera.** (*a*) *Apidae*: 3. Andrena albicans *Müll.* ♀, po-cltg.; 4. A. gwynana *K.* ♀, po-cltg.; 5. A. pratensis *Nyl.* ♀, po-cltg.; 6. A. ventralis *Imh.* ♀ po-cltg., ♂ skg.; 7. Apis mellifica *L.* ☿, freq., skg.; 8. Bombus terrester *L.* ♀, po-cltg. (*b*) *Tenthredinidae*: 9. Dolerus eglanteriae *F.*, skg. **C. Lepidoptera.** 10. Vanessa io *L.*, skg.

Leege observed the following in Juist.—

A. Coleoptera. (*a*) *Coccinellidae*: 1. Coccinella undecimpunctata *L.* (*b*) *Curculionidae*: 2. Sitona lineata *F.* (*c*) *Elateridae*: 3. Cardiophorus griseus *Hbst.*; 4. Limonius cylindricus *Rayk.* (*d*) *Hydrophilidae*: 5. Cercyon haemorrhoidalis *F.* (*e*) *Nitidulidae*: 6. Epurea aestiva *L.*; 7. Meligethes aeneus *F.* **B. Diptera.** (*a*) *Bibionidae*: 8. Bibio marci *L.* ♀ and ♂, very common, skg.; 9. Dilophus vulgaris *Mg.* ♀ and ♂, very common, skg. (*b*) *Muscidae*: 10. Anthomyia lucidiventris *Zett.*; 11. Aricia lucorum *Fall.*; 12. Borborus equinus *Fall.*; 13. Chortophila cinerella *Fall.*; 14. C. latipennis *Zett.*; 15. Cleigastra flavipes *Fall.*; 16. Coenosia decipiens *Mg.*; 17. Cynomyia mortuorum *L.*, rare, skg.; 18. Exorista fimbriata *Mg.*;

19. Gonia fasciata *Mg.*; 20. G. ornata *Mg.*; 21. Hydrella sp.; 22. Hylemyia cinerosa *Zett.*; 23. H. pullula *Zett.*; 24. Lucilia caesar *L.*, freq., skg.; 25. L. sericata *Mg.*; 26. Nemoraea intermedia *Zett.*; 27. Scatophaga stercoraria *L.* ♀ and ♂, very common, skg.; 28. Sepsis cynipsea *L.*, do.; 29. Siphona flavifrons *Zett.*; 30. Spilogaster depuncta *Fall.*; 31. S. duplicata *Mg.* (*e*) *Syrphidae*: 32. Cheilosia praecox *Zett.*, innumerable, skg.; 33. Eristalis arbustorum *L.*, more rare, skg.; 34. E. intricarius *L.*, innumerable, skg.; 35. E. pertinax *Scop.*, freq., skg.; 36. E. tenax *L.*, repeatedly, skg.; 37. Melithreptus scriptus *L.*; 38. Pipizella virens *F.*, freq.; 39. Platycheirus manicatus *Mg.*; 40. Syrphus ribesii *L.*, rare, skg. **C. Hymenoptera.** (*a*) *Apidae*: 41. Andrena albicans *Müll.* one ♂, skg.; 42. Bombus distinguendus *Mor.* ♀; 43. B. lucorum *L.* ♀; 44. B. muscorum *F.* ♀; 45. Colletes cunicularius *L.* ♀ and ♂, in thousands, skg. and po-cltg.; 46. Psithyrus vestalis *Fourcr.* ♀. (*b*) *Tenthredinidae*: 47. Amauronematus viduatus *Zett.* ♀ and ♂, not infreq. **D. Hemiptera.** (*a*) *Cimicidae*: 48. Anthocoris sylvestris *L.*, rare, skg. (*b*) *Pentatomidae*: 49. Gnathoconus albomarginatus *F.*, freq.

Verhoeff records the following for Norderney.—

A. Coleoptera. (*a*) *Elateridae*: 1. Limonius aeruginosus *Oliv.*, one, skg. (*b*) *Nitidulidae*: 2. Epurea aestiva *L.*, 2; 3. Meligethes aeneus *F.*, two. **B. Diptera.** (*a*) *Bibionidae*: 4. Bibio marci *L.* ♀ rare, ♂ rare, skg.; 5. Dilophus vulgaris *Mg.* ♀ very common, ♂ not infrequent, skg. and po-dvg.; 6. Scatopse notata *L.*, a ♀; (*b*) *Muscidae*: 7. Anthomyia muscaria *Zett.* ♂, freq.; 8. A. sp., a ♂; 9. Aricia dispar *Fall.*, a ♂; 10. Calliphora erythrocephala *Mg.* ♀, several times; 11. Cynomyia mortuorum *L.*, 2 ♂ and a ♀; 12. Homalomyia sp., a ♂; 13. Hydrotaea bispinosa *Zett.*, a ♂; 14. Limnophora littorea *Fall.* ♀ and ♂; 15. Lucilia caesar *L.* ♀ not infreq., ♂ freq.; 16. Sepsis cynipsea *L.*, a ♀. (*c*) *Syrphidae*: 17. Eristalis arbustorum *L.*, a ♂; 18. E. intricarius *L.*, one, po-dvg.; 19. Helophilus trivittatus *F.*, 2 ♀, po-dvg. and skg.; 20. Melanostoma mellina *L.* ♂; 21. Platycheirus clypeatus *Mg.* ♂, po-dvg. and skg. (*d*) *Thervidae*: 22. Thereva anilis *L.*, a ♂. **C. Hemiptera.** (*a*) *Cimicidae*: 23. Thriphleps minuta *L.* (*b*) *Pentatomidae*: 24. Corimelaena scarabaeoides *L.* **D. Hymenoptera.** (*a*) *Apidae*: 25. Colletes cunicularius *L.* ♀, skg. and po-cltg., ♂ skg.; 26. Bombus lapidarius *L.*, a ♀, skg.; 27. B. terrester *L.*, a ☿; 28. Psithyrus vestalis *Fourcr.*, a ♀, skg.; 29. Osmia maritima *Friese*, a ♀, skg. (*b*) *Tenthredinidae*: 30. Pachynematus capreae *Pz.*, a ♀. **E. Lepidoptera.** *Lycaenidae*: 31. Polyommatus phlaeas *L.*

Alfken (Bremen), 2 saw-flies (Dolerus madidus *Klg.*, and D. picipes *Klg.*) and 15 bees.—

1. Andrena albicans *Müll.* ♀ and ♂; 2. A. albicrus *K.* ♀ and ♂; 3. A. argentata *Sm.* ♀ and ♂; 4. A. cineraria *L.* ♂; 5. A. convexiuscula *K.* ♀ and ♂; 6. A. morawitzi *Ths.* ♀, very common, skg. and po-cltg., and ♂; 7. A. nigroaenea *K.* ♀ and ♂; 8. A. propinqua *Schenck* ♀ and ♂; 9. A. thoracica *F.* ♀ and ♂; 10. Halictus calceatus *Scop.* ♀, po-cltg. and skg.; 11. H. flavipes *F.* ♀, po-cltg. and skg.; 12. H. rubicundus *Chr.* ♀, po-cltg. and skg., very common; 13. Nomada alboguttata *H.-Sch.* ♂; 14. N. succincta *Pz.* ♀ and ♂, skg.; 15. Osmia rufa *L.* ♂.

The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel, 9. 5.'96), the honey-bee, and the humble-bee Bombus terrester *L.* ♀, skg. and po-cltg., with large pollen-masses on its hind-legs. Friese (Mecklenburg), the humble-bee Bombus jonellus *K.* ♀ (*teste* Brauns), not rare.

2589. S. herbacea L. (Herm. Müller, 'Alpenblumen,' pp. 162–3; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 313.)—The small flowers of this species, arranged in inconspicuous spikes, secrete abundant nectar, and are therefore much visited by insects in spite of their insignificant appearance. Kerner says that the female plants

mature earlier than the adjacent male ones. Warming considers the willows in Greenland (such as S. herbacea, &c.), which flower early and set fruits rapidly, as anemophilous, for the pollen is easily scattered by the wind, but Kornerus says that the fragrant catkins are also occasionally visited by insects.

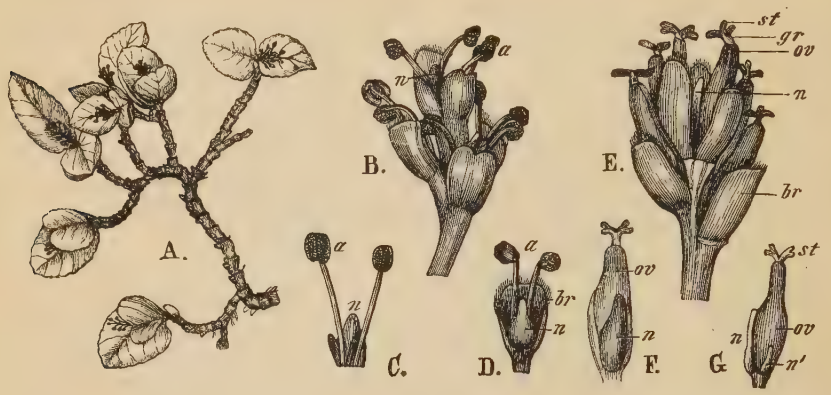


FIG. 363. *Salix herbacea*, *L.* (after Herm. Müller). *A*. Male plant (natural size). *B*. Male spike with five flowers. *C*. Male flower, from outside, after the removal of the bract. *D*. Male flower, from inside. *E*. Female spike with six flowers. *F*. Female flower, from inside. *G*. Female flower, from outside, after removal of the bract. *a*, anther; *br*, bract; *gr*, style; *n* and *n'*, large and small nectaries; *ov*, ovary; *st*, stigmas.

The species was found flowering on Bear Island at the end of June (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' p. 70).

VISITORS.—Herm. Müller (Alps) once observed a moth, and once a Muscid. Lindmann (Dovrefjeld) records flies and humble-bees.

2590. S. polaris Wahlenb. (Lindman, 'Bidrag till Känned. om Skandin. Fjellväxt. Blomn. o. Befrukt.')—Nectar is abundantly secreted in this species also.

This species belongs to the earliest flowering plants of Spitzbergen, where it is in bloom from mid-June to July, fruits being set from the beginning of August to the beginning of September. A hybrid found on the island, S. herbacea × S. polaris (or possibly an intermediate species (?)), is interesting because one parent (S. herbacea) does not now occur there, and this indicates a former wider extension of that species, and a correspondingly altered climate (Andersson and Hesselman, 'Bidrag till Känned. om Spetsbergens o. Beeren Eil. Kärlväxtflora,' pp. 67–9).

VISITORS.—Flies and humble-bees.

2591. S. reticulata L. (Herm. Müller, op. cit., p. 163; Kerner, loc. cit.)—Kerner says that the stigmas of the female flowers of this species mature some days before the anthers of the male ones dehisce.

This species flowers in Spitzbergen later than S. polaris, generally from the middle to the end of July; well-developed fruits were observed on August 10, 1882 (Andersson and Hesselman, op. cit., p. 70). Whether willows are anemophilous in Spitzbergen—as Warming asserts to be the case with Greenland species—requires confirmation. Anemophily is more probable than in Greenland, for there are no humble-bees as in that country. In northern stations generally, e. g. Tromsø, willows

are abundantly visited and pollinated by these insects. Lundström ('Krit. Bemerk. ü. d. Weiden Nowaja-Semljas') asserts that the pollen of northern species of Salix is not so sticky as that of others—owing to the possession of fewer droplets of oil—and is therefore easily dispersed by wind. But the presence of nectaries, even in northern species, is against exclusive anemophily.

Visitors.—Herm. Müller observed a solitary butterfly.

2592. S. retusa L. (Herm. Müller, loc. cit.; Kerner, loc. cit.)—In this species also, according to Kerner, the female flowers mature some days before the male ones.

Visitors.—Herm. Müller observed a single wasp.

MacLeod (Flanders) observed, in willows in which the flowers appear *before* the foliage-leaves, the honey-bee, 3 humble-bees, 18 short-tongued Hymenoptera, 4 hover-flies, 14 other flies, 2 beetles, and a moth (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, pp. 131–3); also, on species in which the flowers and foliage leaves appear simultaneously, the honey-bee, 3 short-tongued bees, 6 hover-flies, and 3 other Diptera (op. cit., p. 133).

Schneider (Arctic Norway) observed the following 9 humble-bees on S. nigricans *Sm.*, S. glauca *L.*, S. Lapponum *L.*, and S. phylicifolia *L.*—

1. Bombus agrorum *F.*, var. arcticus *Acerbi*; 2. B. alpinus *L.*; 3. B. hypnorum *L.*; 4. B. lapponicus *F.*; 5. B. nivalis *Dalhb.*; 6. B. pratorum *L.*; 7. B. scrimshiranus *K.*; 8. Psithyrus quadricolor *Lep.*; 9. P. vestalis *Fourcr.*

809. Populus L.

Flowers anemophilous; dioecious. Pollen scattered, according to Kerner, as in Juglans.

2593. P. nigra L. (Warnstorf, Schr. natw. Ver., Wernigerode, xi, 1896.)—In this species the yellowish bracts of the male spikes are glabrous at the margin, slightly hollowed at the back, and provided with a low swelling round the edge, which makes it difficult for the pollen to slip down. The pollen-grains are pale-yellow in colour, irregularly polyhedral, tuberculate, 30–40 μ in diameter.

Visitors.—Burkill (Yorkshire coast) observed the Muscid Onesia cognata *Mg.*, searching for nectar on ♂ flowers ('Fertlsn. of Spring Fls.').

2594. P. tremula L. (Sprengel, 'Entd. Geh.,' p. 439.)—

Visitors.—Sprengel saw the male flowers of this species visited on the 15th of March, 1790, at Potsdam by numerous pollen-collecting honey-bees; 'The male trees could be recognized and distinguished from the female ones at some distance by the loud buzzing of these insects.'

2595. P. pyramidalis Salisb. (Herm. Müller, 'Weit. Beob.,' II, p. 211.)—

Visitors.—Herm. Müller (Thuringia) observed thousands of po-cltg. honey-bees.

CIV. ORDER *EMPETRACEAE* NUTT.

810. Empetrum L.

Dioecious, sometimes with protandrous hermaphrodite flowers. Warming describes them as anemophilous, but Lindman as entomophilous. The latter

says that the stigma secretes nectar and that the flowers are visited by flies. My observations show them to be anemophilous, receiving occasional insect-visits.

2596. E. nigrum L. (Warming, Bot. Tids., Kjöbenhavn, xv, 1886, pp. 38–9; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 129.)—The male flowers of this species are pink and possess three stamens, with the vestiges of a pistil. The female flowers are purple, with a short style, and crowned by a black, shining stigma with six to nine rays, and a diameter of 2 mm. Lindman says that they secrete sugar which can be detected by Fehling's solution.

Besides dioeciously, rarely monoeciously distributed unisexual flowers, Lindman observed occasional protandrous hermaphrodite ones. Warming found the plants in Greenland to be dioecious only, with a majority of male flowers. I have never had an opportunity of observing the plant during anthesis in the North Frisian Islands. Considering its early flowering, the absence of insects at that time (in addition to their scarcity in general in these islands, particularly in April), the frequency of heavy storms just then, and the almost unfailing abundance of fruit-formation in the islands of Sylt, Amrum, and Föhr, I conclude that the species is anemophilous; on the other hand, the colour of the flowers and the secretion of nectar by the stigma point to occasional insect-visits, probably of flies.

Andersson and Hesselman found gynomonoecious plants of this species flowering in Spitzbergen during July ('Bidrag till Känned. om Spetsbergens o. Beeren Eil. Kärlväxtflora,' pp. 31–2). They have not so far observed ripe fruits, but G. Andersson obtained well-developed 'pips' in samples of mud from the Mytilus layers of Advent Bay.

Male, female, and hermaphrodite stocks, and also numerous fruits, have been observed in Greenland (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' pp. 13–14).

Visitors.—Nylander (Finland) observed the bee Colletes cunicularius *L.*, and Höppner (Bremen) the bee Andrena convexiuscula *K.*

CV. ORDER *CERATOPHYLLACEAE* GRAY.

811. Ceratophyllum L.

Flowers hydrophilous; monoecious.

2597. C. demersum L. (Ludwig, 'Zur Biol. d. phanerog. Süsswasserflora,' pp. 8–11; Rodier, C.-R. Acad. Sci., Paris, 1877; Beyer, 'D. spont. Beweg. d. Staubgef. u. Stempel'; Vaucher, 'Hist. physiolog. d. pl. d'Europe,' II, 1841.)—In 1841 Vaucher described the pollination of species of Ceratophyllum by the pollen floating in water as a granular substance; F. Ludwig's detailed investigations not only confirmed this, but showed that these are the only plants growing in fresh water which are strongly hydrophilous, though there are several such among marine flowering plants. Ludwig summarizes the results of his investigations (op. cit.) somewhat in the following manner.—Male and female flowers are nearly sessile, and occur separately, irregularly arranged in different leaf-whorls, the female ones seeming to predominate below. The male flowers, with abundant stamens and pollen, are

much more numerous than the female. These possess a polyphyllous perianth surrounding an ovoid ovary with a style projecting beyond the perianth to a distance of four to five times the length of the latter; it is bent downwards like a hook, and tapers towards the point: this is not papillose, but its whole lower side, which secretes a sticky substance, serves as a stigma.

The male inflorescence consists of 12–16 very short-stalked anthers, which are enclosed in a polymerous involucre. Each stamen is made up of a short filament, and two anther-lobes, opening laterally by longitudinal slits, and composed at the tip of loose, air-containing tissue produced into two small, thorn-like processes curved towards the middle, between which there is generally a blackish, more or less vertical, tubercle-like gland. Stahl ('Pfl. u. Schnecken') says that these apical appendages of the stamens contain tannin, and form an effective protection against water-snails and other vegetarian aquatic creatures. Ludwig has described the cellular tissue found below these points as a 'float', as it makes the whole stamen specifically lighter than water, and therefore carries it to the surface, when it is freed from the flower. The round or long pollen-grains are surrounded by a delicate membrane only, and possess no extine. Their specific gravity is exactly the same as that of water, so that they float at any depth. This varying specific gravity of the pollen-grains and the whole pollen-bearing mechanism, together with the retention of the stiff-leaved involucre, determines the method of transport of pollen. The involucral bracts have a tendency to bend inwards (on empty inflorescences they are vertical), so that the stamens have not enough room when fully mature. When the anthers dehisce, the stamens are forced out of the involucre and come to the surface by the help of the 'float,' or, as more frequently happens, are held back between the hooked leaves of the upper nodes. During this upward movement the anthers dehisce, being greatly assisted in this by the vertical position of the stamen maintained by the 'float'; the pollen, being of the same specific gravity as the water, spreads over the whole space touched by the stamens; the water, therefore, in which the plant grows, is everywhere full of the large pollen-grains (40–50 μ broad and 50–75 μ long). The peculiar movement of the stem is useful in the spreading of pollen, particularly in still water, where it is of inestimable value. E. Rodier first described this movement as follows.—The young flower-bearing internodes move independently of light, the stems as a rule bending from right to left in the morning and from left to right after midday. Sometimes in six hours angles of 200° are described. Besides this the branches undergo twisting movements around their axis of growth. The stem begins to bend at the tip, continuing downwards with decreasing strength, while the backward movement begins at the base and works upwards, so that the last internodes, just before bending backwards, sometimes form an acute angle with the axis. As pollen is formed very abundantly, the movements just described ensure the pollination of the long, filiform stigmas of the female flowers, which mature somewhat before the anthers. F. Ludwig did not observe the simultaneous movement of female flowers towards the surface (mentioned by Hermann Beyer), on which the pollen last dehisced floats.

2598. C. submersum L.—The mechanism of this species agrees with that of the preceding one.

ANGIOSPERMAE

CLASS II. MONOCOTYLEDONES

CVI. ORDER *HYDROCHARIDEAE* DC.

Literature.—Ascherson u. Gürke, 'Hydrocharitaceae,' in Engler u. Prantl's 'D. nat. Pflanzenfam.,' II, 1, pp. 244–5.

Kerner's description ('Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 130–3) of the flower mechanism of Vallisneria spiralis *L.*, V. alternifolia *L.*, Enalus acoroides *L.*, Hydrilla verticillata *L.*, Elodea canadensis *Michx.*, and species of the genus Lagarosiphon, has been given in Vol. I of this work, pp. 68–9.

Flowers monoecious, dioecious, trioecious or hermaphrodite. Entomophilous or hydrophilous.

812. **Hydrilla** Rich.

Flowers hydrophilous; monoecious.

2599. H. verticillata Presl. (Ascherson u. Gürke, op. cit.)—The short-stalked male flowers of this species are solitary. At the time for pollination they separate from the submerged plant and float on the surface of the water. The female flowers possess a calyx-tube elongated to a thread (which Ascherson describes as an ovary), and three filiform stigmas, which are pollinated by the floating male flowers.

813. **Elodea** Mich.

Flowers hydrophilous; trioecious.

2600. E. canadensis Michx. (Ascherson u. Gürke, op. cit.)—It is a familiar fact that only the female plant of this species has been imported into Europe, and this propagates freely in a vegetative manner. In North America the plant is trioecious and hydrophilous. As in Hydrilla verticillata the male flowers separate from the plant and float on the surface of the water, where they reach fixed female ones, of which the inferior ovary is prolonged into a thread, so that its purple stigmas can be pollinated by the male flowers.

814. **Vallisneria** L.

Flowers hydrophilous; dioecious.

2601. V. spiralis L. (Delpino, 'Ult. oss.,' II.)—The submerged plants of this South European species free their numerous male flowers, which are situated on short, radical stalks, at the time for pollination, so that they rise to the surface of the water. At the same time the female flowers unroll their spiral, filiform stalks, being thus brought to the surface, where they are pollinated by the male flowers. After pollination the flower-stalks once more roll up, bringing the flowers back to their original position where the fruits are set. (*Cf.* Vol. I, p. 69.)

815. Stratiotes L.

Flowers dioecious; white; with half-concealed nectar.

2602. S. aloides L. (Sprengel, 'Entd. Geh.,' pp. 441–2; Nolte, 'Bot. Bemerk.'; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 286; Ascherson, Verh. bot. Ver., Berlin, xvii, 1875, pp. 80–5; Knuth, 'Bloemenbiol. Bijdragen.')—MacLeod states that the male flowers of this species possess about 12 fertile stamens and 15–30 sterile ones; the latter serve as nectaries and are situated between the ordinary stamens and the petals. The nectaries of the female flowers are like those of the male ones. In many districts, e. g. Scandinavia and Denmark, only the female plant occurs; this seems also to be the case in North Schleswig, while in Holstein the male plant is not rare. The nectaries in both flowers consist of numerous bright yellow, glandular threads. Nolte says that fruit- and seed-formation take place even without fertilization, and prolific vegetative propagation is effected from the rhizome.

Visitors.—Knuth observed the hover-fly Eristalis tenax *L.*

816. Hydrocharis L.

Flowers dioecious; with half-concealed nectar.

2603. H. Morsus-ranae L. (Delpino, 'Ult. oss.,' II; Ascherson u. Gürke, op. cit.; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 285–6; Knuth, 'Bloemenbiol. Bijdragen'; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The white petals in this species possess a nectar-scale on the inner surface of their bases. The flowers of each kind show vestiges of the opposite sex. Warnstorf says that the yellow stamens possess broad papillose filaments; the anthers dehisce by a lateral slit. The pollen-grains are yellow in colour, rounded tetrahedral, beset with spines causing them to cling to one another and to the walls of the anthers for a long time. The stigmas of the female flowers are yellow in colour, grooved internally, or forked and closely beset with long papillae.

Visitors.—Knuth observed numerous honey-bees, skg.

CVII. ORDER *ORCHIDEAE* JUSS.

Literature.—Darwin, 'Orchids'; Herm. Müller, 'Fertilisation,' pp. 527–41; Pfitzer, *vide* Bibliography, Vol. I, p. 330, Nos. 2782–4; Knuth, 'Grundriss d. Blütenbiol.,' pp. 95–6; Kirchner, 'Flora v. Stuttgart,' p. 163.

Orchids are distinguished by a greater variety of flower-forms than any other order of plants. These forms are adapted in such a remarkable way for cross-pollination by insects that the structure of the flower corresponds in its smallest details to peculiarities of their bodies. Automatic self-pollination therefore only occurs as an exception (*e.g.* Ophrys apifera *Huds.* is self-fertile, according to Darwin), and is much more generally excluded by the relative positions of stigmas and anthers; but these opposite conditions are united by an uninterrupted chain of transitions, as the following list, drawn up by Hermann Müller, shows:

1. Cleistogamous flowers:—Schomburgkia, Cattleya, Epidendrum (H. Crüger), Dendrobium (Anderson).

2. Open, regularly self-fertilized flowers:—Ophrys apifera *Huds.*, Habenaria intacta *Benth.*, Gymnadenia tridentata *Hook.*, Habenaria hyperborea *R. Br.* (Darwin), Epipactis atrorubens *Schult.* (Hermann Müller), Epidendrum (F. Müller).

3. Occasional or exceptional autogamy: Neottia Nidus-avis *Rich.* (frequent). and Listera ovata *R. Br.* (exceptionally) (Darwin).

4. Never autogamous, but completely self-fertile.

5. Completely self-sterile, but fertile with foreign pollen, not only of the same, but of other species of the same genus; species of Oncidium (J. Scott).

6. Killed by geitonogamy; species of Oncidium, Notylia, Gomeza, Stigmatostalix, Burlingtonia (Fritz Müller).

Ridley (J. Linn. Soc. Bot., London, xxiv, 1888) describes a still larger number of orchids as cleistogamous or autogamous: Eulophia monophylla *S. Moore*, Trichopilia fragrans *Reichb.*, Dendrobium roseum *Sw.* (cleistogamous). He gives (op. cit.) the following cases of autogamy:—

1. The pollen-grains separate from one another and fall from the anther directly upon the stigma or on to the labellum, which comes into contact with this: Ophrydeae, Neottieae, Thelymitra longifolia *Forst.*, Spiranthes australis *Lindl.*

2. Complete pollinia fall from the anther upon the stigma: Phaius maculatus *Blume*, Chiloglottis diphylla *R. Br.*, Arundina densa *Lindl.*

3. Either the pollinia fall completely from the anther as before, or the bursicula, caudicles, and disk remain attached to the column: Ophrys apifera *Huds.*, Eulophia monophylla *S. Moore*, Trichopilia fragrans *Reichb.*, Eria sp., Spathoglottis Paulineae *F. Muell.*

4. Overflow of stigmatic fluid: Cephalanthera pallens *Rich.*, Epipactis atrorubens *Schult.*, Spiranthes australis *Lindl.*, Phaius Wallichii *Lindl.*; and also Spathoglottis plicata *Blume*, Schomburgkia, Epidendrum, Cattleya, Thelymitra, Orthoceras, &c.

Self-fertilizing species are thus very widely distributed (Justs bot. Jahresber., Leipzig, xvi, (1888) 1890, pp. 561–2).

The three sepals and the two upper petals frequently form a helmet-shaped protecting roof for the inner parts of the flower. Of the original three stamens there is generally only one present (rarely two), sessile on a column and bearing the stigma on its anterior (upper) side in the form of a small, sticky, glandular depression. The column frequently ends in a small process, the rostellum, above the stigma; behind it are situated one or two glands, entirely or partially covered by a hood-like or elastic skin, which contain a tenacious, viscid fluid. The filament is entirely united with the rostellum, so that only the anther is visible; this consists of two lobes which dehisce longitudinally each containing a pollinium; the latter is made up of little packets of united pollen-grains, which are fastened together by slender elastic threads into club- or pear-shaped cohering masses. The lower end of the pollinia are firmly united with the glands containing viscid substance.

Pfitzer says that most orchids are distinguished by an exceptionally long period of anthesis. Only a small number, such as the flowers of Sobralia, Restrepia, and Cirrhopetalum, fade in a few days; in most genera the single blossoms remain

perfectly fresh for 30–40, and in some cases for 70 or 80 days, if they are not pollinated. Opportunity for pollination is thus offered to insects for a long time. A flower which has been pollinated, however, fades very quickly, as there is no further need for its remaining fresh. Large numbers of flowers open simultaneously as a rule. In the case of Paphiopedilum and others it also happens sometimes, however, that on a long raceme only one flower is open at a time. As this remains fresh for about a month, the plant can offer a flower to insects for years without intermission.

Maury (C.-R. Acad. Sci., Paris, ciii, 1886, pp. 357–9) states that the flowering season in our native species usually lasts only $\frac{1}{2}$–2 months.

Pfitzer goes on to say that insects are attracted to visit the flower partly by its size and beautiful colouring, and partly by particular odours, and there are not only many very fragrant species, but also others which attract carrion flies by their smell of putrefying flesh: Bulbophyllum Beccarii *Reichb. f.* surpasses the Aroids and Stapelias in this respect.

Nectar is concealed in very various ways, usually at the base of a spur; this, however, sometimes does not contain free nectar, the secretion being attainable by boring only (e. g. Orchis).

In order to afford flying insects a convenient alighting-platform, most orchids undergo torsion in the bud through 180° so as to bring the originally upwardly directed labellum to the under-side.

Some species possess two forms of flowers, e. g. Renanthera Lowei *Reichb. f.*, in which the upper flowers of the very long inflorescences are yellow with small brown spots, while the rest are almost entirely brown and of a different shape. This peculiarity is most striking in Catasetum, where the same plant sometimes bears flowers of different form in different years, and sometimes all the forms on the same inflorescence. (Justs bot. Jahresber., Leipzig, xvi, (1888) 1890, p. 561.)

Not only do the visitors to our native orchids belong to the most various groups of insects, but perhaps (in species of Cypripedium) snails sometimes serve as pollinators. Of the better known species the following are pollinated as follows:—by humble-bees, species of Orchis, Epipogum aphyllum *Sw.*, Goodyera repens *R. Br.*, Spiranthes autumnalis *Rich.*; by bees, species of Orchis, Epipactis palustris *Crantz*, species of Cypripedium; by wasps, Epipactis latifolia *All.*; by ichneumon-flies, Listera ovata *R. Br.*; by moths, Habenaria bifolia *R. Br.*, H. conopsea *Benth.*; by flies, species of Orchis, Epipactis palustris *Crantz*, Neottia Nidus-avis *Rich.*; by beetles, Listerata ovata *R. Br.*

The foundations of the study of orchid flower mechanism have been laid down by Darwin in his classical pioneer work, 'The Various Contrivances by which British and Foreign Orchids are Fertilized by Insects' (1st Ed., London, 1862), which must be read by every one desirous of understanding the flower mechanisms of this order. In what follows, therefore, I simply give a brief account of the mechanisms of European species.

817. Orchis L.

As in many other genera of this order, the three sepals, and the two upper petals form a protecting roof for the central part of the flower. The labellum,

provided with a nectar-guide, forms a convenient alighting-platform for insects. Its cylindrico-conical spur does not secrete nectar, but affords a liquid[1] enclosed in cellular tissue to visitors, which extract it by boring. The two anther-lobes are firmly united with the column, each possessing a special adhesive disk covered by a bursicula. There is a rostellum between the two anther-lobes, which presses them apart; they dehisce in the front by means of a longitudinal slit from top to bottom, the front of the pollinia being thus exposed; these contract into a sort of stalk towards the base and are here united to the epidermis of the bursicula.

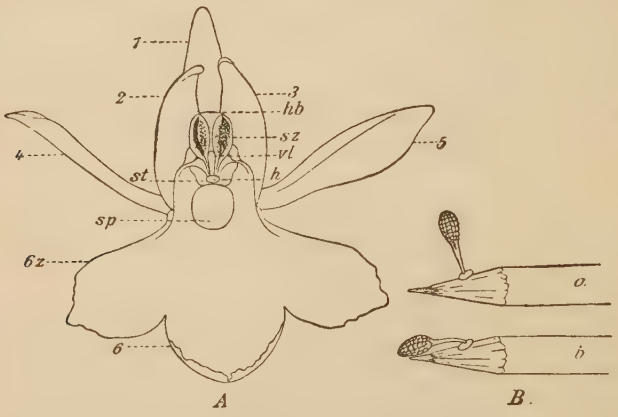


FIG. 364. *A*. Flower of *Orchis maculata*, *L*. (after F. MacLeod). (1, 2, 3) The sepal and upper petals which make up a protective roof. (4, 5) Lateral sepals. (6) Labellum. (6 *z*) Lateral lobes of do. *h*, bursicula; *hb*, uppermost part of protective roof; *sp*, entrance to the spur; *st*, stigma; *sz*, open anther loculus with pollinium; *vl*, membranous appendage of *h*.

B. Pollinium of *Orchis mascula*, *L*. (J. MacLeod after Darwin). *a*, immediately after withdrawal from the anther (on a pencil); *b*, do., bent forward, after exposure to the air.

An insect inserting its proboscis into the spur strikes its head against the bursicula, the epidermis of which is ruptured, so that the two small, circular adhesive disks at the ends of the pollinia cling to the visitor's head and become firmly fastened to it by the immediate hardening of the viscid substance. On withdrawing its head from the spur the insect thus removes the pollinia; the pollen-masses are drawn out of their receptacles and harden in the open air, their caudicles bending more and more forward. (This process can easily be imitated by means of a small sharp style or pencil.) The pollinia ultimately turn through an angle of almost 90°, so that when the insect visits another flower they strike directly against the stigmatic surface situated below the rostellum in the entrance of the spur. As the adhesiveness of the stigma is greater than that of the pollinia to the insect, they are torn away and left behind when it backs out of the spur. Cross-pollination therefore always takes place when insects visit the flowers, and not only crossing with separate flowers, but also with separate stocks, may be effected if the insect has visited another plant during the time necessary for the bending forward of the pollinia. Should insect-visits fail no fertilization takes place, because automatic self-pollination is impossible.

[1] *Cf.* the footnote on Leucojum aestivum *L*.

The following observations have been made about the odours of some species. Kerner describes O. pallens *L.* as possessing an odour of elder, O. longibracteata *Bivona*, a somewhat goat-like smell (though Bourdette states that it is fragrant), and O. coriophora *L.* that of bugs. In dried (not pressed) specimens of O. militaris *L.*, and sometimes of some others, Holmgren observed a strong vanilla-odour and later on an equally strong smell of cumarin.

2604. O. latifolia L. (Sprengel, 'Entd. Geh.,' pp. 401–4; Darwin, 'Orchids,' pp. 15–16; Herm. Müller, 'Fertilisation,' p. 539, 'Alpenblumen,' p. 63; Knuth, 'Bloemenbiol. Bijdragen.')—

Visitors.—Herm. Müller (H. M.) and Knuth (Kn.) give the following list of bees.—

Hymenoptera. *Apidae*: 1. Apis mellifica *L.* ☿ (Kn., H. M.); 2. Bombus agrorum *F.* (H. M.); 3. B. confusus *Schenck* (H. M.); 4. B. distinguendus *Mor.* (H. M.); 5. B. hortorum *L.* ♀ (Kn., H. M.); 6. B. lapidarius *L.* ♀ (Kn., H. M.); 7. B. muscorum *F.* (H. M.); 8. B. terrester *L.* (Kn., H. M.); 9. Eucera longicornis *L.* (Kn., H. M.); 10. Halictus leucozonius *Schr.* ♀ (H. M.); 11. Nomada sexfasciata *Pz.* ♀ (H. M.); 12. Osmia fusca *Chr.* (=O. bicolor *Schr.* ♀) (H. M.).

The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 2 humble-bees. Scott-Elliot (Dumfriesshire), an Empid and a hover-fly ('Flora of Dumfriesshire,' p. 165).

2605. O. mascula L. (Darwin, op. cit., pp. 6–15; Herm. Müller, op. cit., p. 538.)—

Visitors.—Herm. Müller gives the following list of humble-bees.—

1. Bombus agrorum *F.*; 2. B. confusus *Schenck*; 3. B. hortorum *L.*; 4. B. lapidarius *L.*; 5. B. pratorum *L.*; 6. B. terrester *L.*; 7. Psithyrus campestris *Pz.*; 8. B. muscorum *L.* (?) (observed by a friend of Darwin's).

2606. O. Morio L. (Sprengel, 'Entd. Geh.,' pp. 404–5; Herm. Müller, op. cit., p. 539.)—

Visitors.—Darwin (D.) and Herm. Müller (H. M.) record the following bees.—

1. Apis mellifica *L.* ☿ (D., H. M.); 2. Bombus agrorum *F.* (D.); 3. B. confusus *Schenck* (H. M.); 4. B. hortorum *L.* (H. M.); 5. B. lapidarius *L.* (H. M.); 6. B. pratorum *L.* (H. M.); 7. B. sylvarum *L.* (H. M.); 8. Eucera longicornis *L.* (D.); 9. Osmia rufa *L.* (H. M.).

2607. O. maculata L. (Darwin, op. cit., pp. 15–16; Herm. Müller, op. cit., p. 539, 'Alpenblumen,' p. 63, 'Weit. Beob.,' I, p. 291; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—Warnstorf described the stalked greenish pollinia in this species as made up of groups of numerous pollen-grains, and shaped like a blunt pyramid or cone (up to 360 μ in length).

Visitors.—Herm. Müller observed the following in Central Germany.—

A. Coleoptera. *Cerambycidae*: 1. Strangalia atra *Laich.* **B. Diptera.** (*a*) *Empidae*: 2. Empis livida *L.*; 3. E. pennipes *L.*, both observed by George Darwin with pollinia fixed to their eyes. (*b*) *Syrphidae*: 4. Eristalis horticola *Deg.*; 5. Volucella bombylans *L.*, very common; both with pollinia adhering to the front of the head. **C. Hymenoptera.** *Apidae*: 6. Bombus pratorum *L.* ☿.

The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 2 humble-bees. Alfken (Bremen), the humble-bee Bombus agrorum *F.* ♀. MacLeod (Flanders) (Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 316–23).—**A. Coleoptera.** *Cerambycidae*: 1. Leptura melanura *L.*, numerous. **B. Diptera.** (*a*) *Empidae*: 2. Empis decora *Mg.*, skg. (*b*) *Muscidae*: 3. Lucilia sp. **C. Hymenoptera.** 4. Small ants.

2608. O. globosa L. (Herm. Müller, 'Alpenblumen,' pp. 61–76.)—This species bears butterfly flowers.

Visitors.—Herm. Müller observed 8 butterflies.

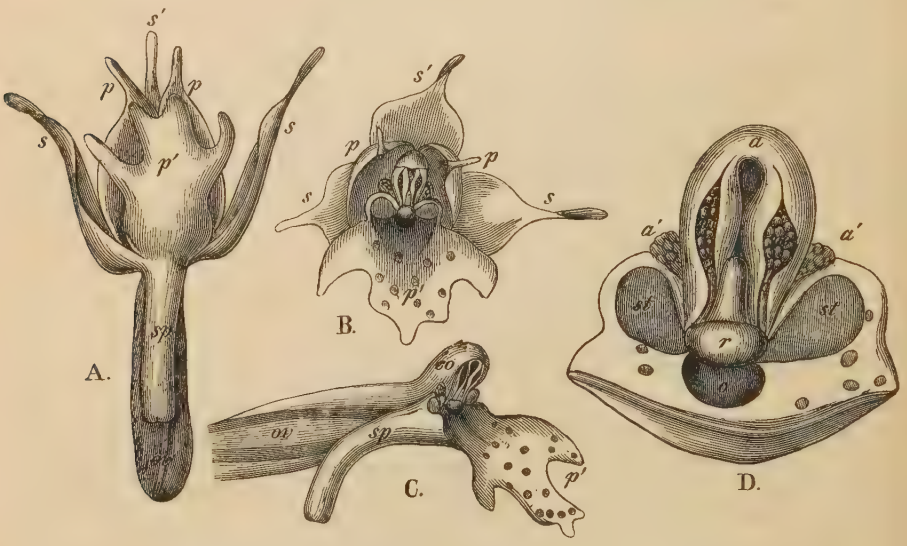


Fig. 365. *Orchis globosa*, *L.* (after Herm. Müller). *A.* Flower, seen from below. *B.* Do., seen almost directly from the front. *C.* Do., after removal of all the perianth leaves except the labellum, seen obliquely from the side (× 7). *D.* Reproductive organs and base of the labellum, seen directly from the front (× 27). *a*, anther; *a' a'*, vestigial anthers; *co*, corolla; *o*, entrance to spur; *ov*, ovary; *p p*, upper petals; *p'*, labellum; *r*, rostellum; *s s*, lateral sepals; *s'*, upper sepal; *sp*, spur; *st*, stigma.

2609. O. purpurea Huds. (=O. fusca *Jacq.*). (Darwin, op. cit., p. 15.)—Darwin states that the flower mechanism of this species is the same as that of O. mascula.

2610. O. ustulata L. (Darwin, op. cit., p. 25; Herm. Müller, 'Alpenblumen,' pp. 59–61.)—This species bears Lepidopterid flowers. The very narrow entrance to the spur, which is scarcely 2 mm. long, indicates small, short-tongued butterflies as visitors.

2611. O. tridentata Scop. (Herm. Müller, 'Weit. Beob.,' I, p. 291.)—

Visitors.—Herm. Müller jr. (Jena) saw the humble-bee Bombus hortorum *L.* ♀, with pollinia adhering to the front of its head.

2612. O. sambucina L.—

Visitors.—Hoffer (Steiermark) saw the humble-bee Bombus mastrucatus *Gerst.* ♀.

2613. O. pyramidalis L. (=Anacamptis pyramidalis *Rich.*). (Darwin, op. cit., pp. 16–25; Herm. Müller, 'Fertilisation,' p. 534; Kirchner, 'Flora v. Stuttgart,' p. 169.)—The mechanism of the carmine-red or flesh-coloured, fragrant flowers of this species agrees with that of Orchis. They secrete free nectar, however, which is concealed in such a narrow spur that it is only accessible to the thin proboscis of a Lepidopterid. Two longitudinal ridges on the labellum serve as guides. There is a circular stigmatic surface situated on each side of the rostellum. The gland containing mucilage is saddle-shaped, corresponding to the shape of the Lepidopterid proboscis, to which the pollinia will cling. When the epidermis of the rostellum has been torn by the proboscis of a lepidopterid visitor, the gland, with the two pollinia, adheres so firmly to this organ as to surround it when the mucilage dries. The two

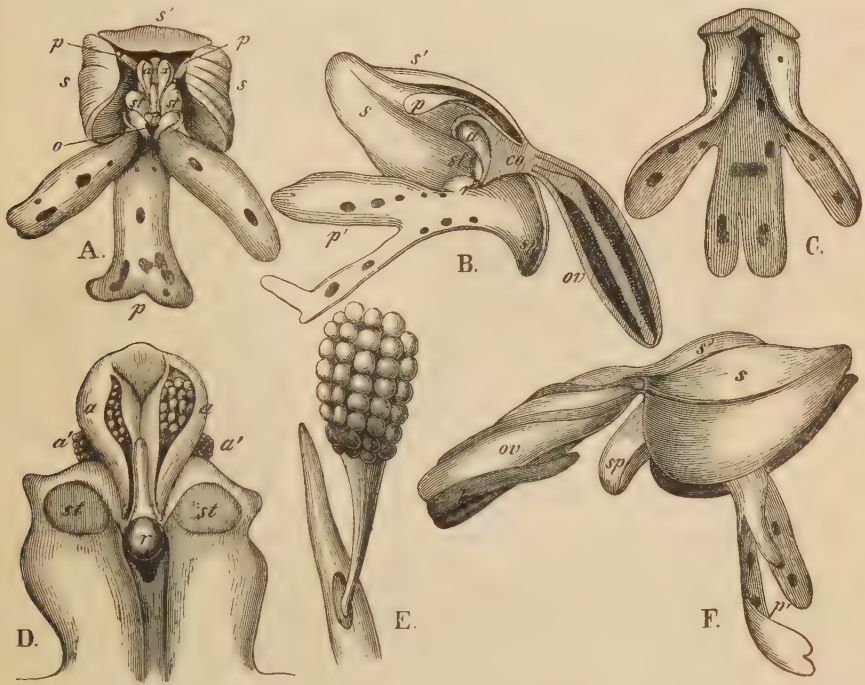


FIG. 366. *Orchis ustulata*, *L.* (after Herm. Müller). *A*. Flower, seen directly from the front (× 7). *B*. Do., in longitudinal section. *C*. Excised labellum, seen from above. *D*. Reproductive organs and root of labellum, seen directly from the front (× 16). *E*. A pollinium attached to a needle (forward and downward bending completed) (× 35). *F*. Older flower, seen from the side (× 7). Reference letters as Fig. 365.

pollinia now bend simultaneously outwards and forwards, so that when the insect carrying them visits another flower of this species they are pressed directly on to the two stigmatic surfaces.

VISITORS.—Darwin observed 23 species of butterflies and moths with pollinia attached to their proboscis.

2614. O. hircina Crantz (=Himantoglossum hircinum *Spreng.*, and Satyrium hircinum *L.*). (Hildebrand, Bot. Ztg., Leipzig, xxxii, 1874, p. 748.)—The inner side of the white helmet in the (?) bee flowers of this species is purple-red in colour with

green stripes. The labellum is whitish-green with reddish spots and possesses a very long middle lobe. The whole flower exhales an odour of goats. Kerner says that it smells like caproic acid.

Visitors.—Hildebrand observed a bee.

818. Habenaria Willd.

Lepidopterid flowers.

2615. H. conopsea Benth. (=Gymnadenia conopsea *R. Br.*, and Orchis conopsea *L.*). (Herm. Müller, 'Alpenblumen,' pp. 63–5; Darwin, op. cit., pp. 65–8; Kirchner, 'Flora v. Stuttgart,' p. 170.)—The flowers of this species exhale an odour of pinks, and are generally purple-red in colour, rarely white. In the former case they are more adapted for pollination by butterflies, in the latter by moths. The spur, which is 13–15 mm. long, frequently contains such abundant nectar that it is filled high up with it. The two long, narrow, naked disks are situated close

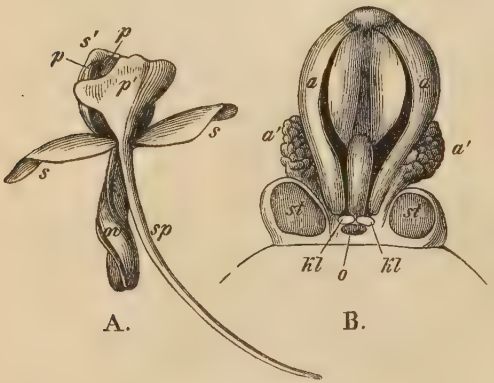


Fig. 367. *Habenaria conopsea, Benth.* (after Herm. Müller). *A.* Flower, seen from below (× 3). *B.* Reproductive organs of do., seen directly from the front (× 20). *aa*, anther; *a' a'*, vestigial anthers; *kl kl*, adhesive disks; *o*, opening of spur; *ov*, ovary; *pp*, upper petals; *p'*, labellum; *ss*, lateral sepals; *s'*, upper sepal; *sp*, spur; *st st*, stigmatic surfaces.

Fig. 368. *Habenaria odoratissima, Franch.* (after Herm. Müller). *C.* Flower, after removal of all the sepals and the petals except spur of labellum: seen from the front (× 7). *D.* Flower, seen from below (× 3). *h*, height to which nectar rises in the spur; remaining letters as in Fig. 367.

in front of the entrance to the spur, which is very narrow and therefore affords a passage for the proboscis of a Lepidopterid only. The pollinia torn out by the proboscis bend very quickly and strongly. The flower mechanism otherwise agrees essentially with that of Orchis pyramidalis. Self-pollination is excluded. Warnstorf describes the pollinia as very variable in length, grey-greenish in colour, consisting of masses composed of numerous pollen-grains, which are sometimes rounded tetrahedral in form, sometimes bluntly cuboidal, sometimes resemble blunt cones or pyramids, and are very variable in length.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 26 species of Lepidoptera. George Darwin, several moths. Loew (Silesia, 'Beiträge,' p. 54), the Telephorid beetle Cantharis albo-

narginata *Märk.* Scott-Elliot (Dumfriesshire), a hover-fly and a Lepidopterid ('Flora of Dumfriesshire,' p. 168).

2616. H. odoratissima Franch. (=G. odoratissima *Rich.*, and Orchis odoratissima *L.*). (Herm. Müller, 'Alpenblumen,' pp. 65–6.)—The mechanism of the vanilla-scented, pale pink flowers of this species resembles that of the preceding one, but the spur is only 4–5 mm. long and about half filled with nectar. The pale colour and stronger fragrance attract moths more particularly.

Visitors.—Herm. Müller observed 3 species of Lepidoptera.

2617. H. albida R. Br. (=Gymnadenia albida *Rich.*, and Orchis albida *L.*). Darwin, op. cit., pp. 43, 68; Herm. Müller, 'Alpenblumen,' p. 66.)—The white flowers of this species are fragrant (also in the arctic regions, according to Warming), and the entrance to the spur is so narrow that only a lepidopterid proboscis can enter it. The white colour of the flowers points to moths as visitors, and the shortness of the spur (2 mm.) indicates adaptation to small species.

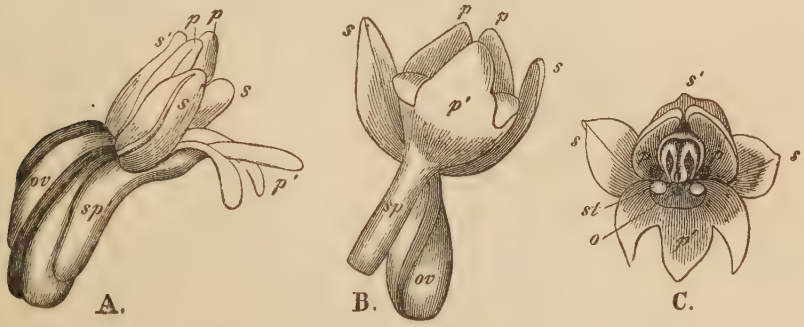


Fig. 369. *Habenaria albida*, *R. Br.* (after Herm. Müller). *A*. Flower, seen from the side. *B*. Do., from below. *C*. Do., from the front (× 7). *o*, opening of the spur; *ov*, ovary; *p p*, upper petals; *p'*, labellum; *s s*, lateral sepals; *s'*, upper sepal; *sp*, spur: *st*, stigmatic surface.

2618. H. angustifolia H. B. et K. (=Nigritella angustifolia *Rich.*, Orchis nigra *Scop.*, and Satyrium nigrum *L.*). (Herm. Müller, 'Alpenblumen,' pp. 66–9; Ricca, Atti Soc. ital. sc. nat., Milano, xiv, 1871; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 201.)—The flowers of this species are dark purple-red, rarely pink in colour, with a strong vanilla odour, and the spur is only 2 mm. long and one mm. wide. The flower mechanism agrees otherwise with that of the remaining lepidopterid orchids, e.g. in regard to richness in nectar, and the adhesive disks with pollinia situated upon them, which when drawn out bend forwards and outwards; but the position of the parts of the flower is reversed, so that the pollinia cling to the lower side of the proboscis and are then brought on to the stigmas situated below the narrow entrance to the spur. Self-pollination is excluded.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), no less than 53 insects, including 48 Lepidoptera. Loew (Switzerland, 'Beiträge,' p. 63), 2 butterflies—Argynnis pales *S.-V.* and Melitaea parthenie *Bkh.*

2619. H. suaveolens Dalz. (= Nigritella suaveolens *Koch*, and H. angustifolia *H. B. et K.* × H. conopsea *Benth.*). (Herm. Müller, 'Alpenblumen,' pp. 69–70; Kerner, op. cit., pp. 563, 586.)—This is a hybrid between two lepidopterid species. The colour of the flowers is between carmine and pink. The possibility of

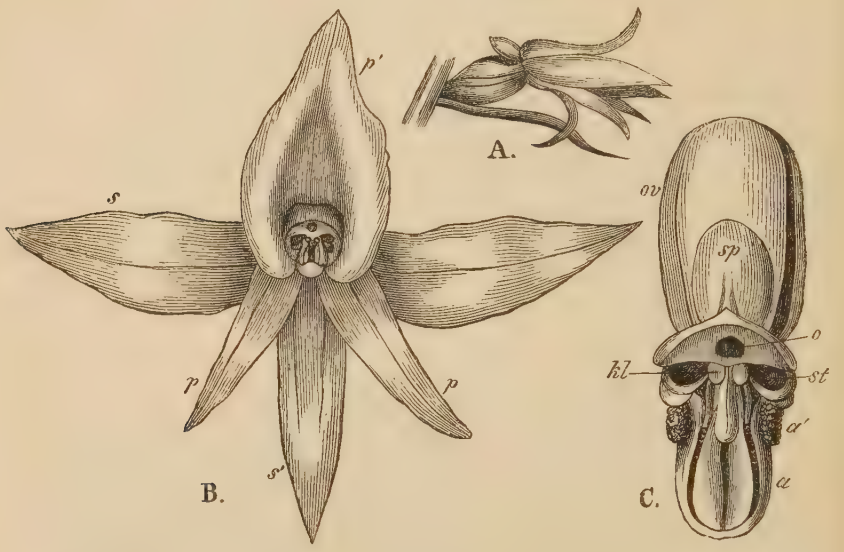


FIG. 370. *Habenaria angustifolia*, *H. B. et K.* (after Herm. Müller). *A.* Flower, seen from the side (× 2⅔). *B.* Do., seen directly from the front (× 7). *C.* Reproductive organs and nectary, seen obliquely from above (× 15). *a*, anther; *a'*, vestigial do.; *kl*, adhesive disk; *o*, opening of spur; *ov*, ovary; *p p*, lower petals; *p'*, labellum; *s*, lateral sepal; *s'*, lower do.; *sp*, spur; *st*, stigmatic surface.

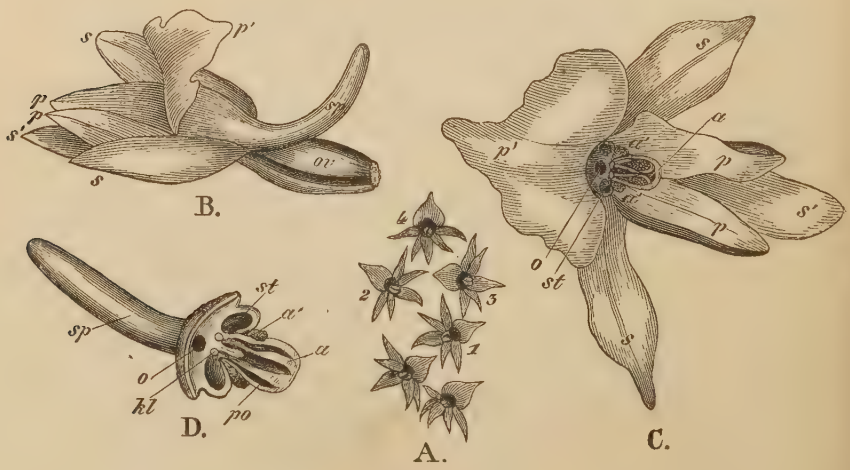


FIG. 371. *Habenaria suaveolens*, *Dalz.* (after Herm. Müller). *A.* Several flowers in their natural position (× 1)—1, twisted to the left; 2 and 3, twisted to the right; 4, not twisted. *B.* A flower, seen obliquely from the left and above (enlarged). *C.* Do., in its natural position. *D.* Reproductive organs and nectary (× 7). *a*, anther; *a' a'*, vestigial do.; *kl*, disk; *o*, opening of spur; *ov*, ovary; *p p*, lower petals; *p'*, labellum; *s s*, upper sepals; *s'*, lower sepals; *sp*, spur; *st*, stigma.

hybridization by Lepidoptera between two species which have fixed their pollinia to the upper and lower sides of the proboscis respectively, arises from the fact that the flowers are sometimes half twisted round thus making transfer possible.

2620. Habenaria bifolia R. Br. (=Platanthera bifolia *Rich.*; P. solstitialis *Boenn.*; Orchis bifolia *L.*; and Gymnadenia bifolia *Meyer*). (Darwin, op. cit., pp. 73–4; Herm. Müller, 'Fertilization,' p. 533, 'Alpenblumen,' pp. 70–2; Kirchner, 'Flora v. Stuttgart,' p. 171; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 323; Sprengel, 'Entd. Geh.,' pp. 405–6.)—The white moth flowers of this species exhale a strong odour of pinks, particularly at night, and have a thin spur 13–21 mm. long, which is often three-quarters full of nectar. The pollinia adhere to the left and right sides of the proboscis of a moth, then turn in- and

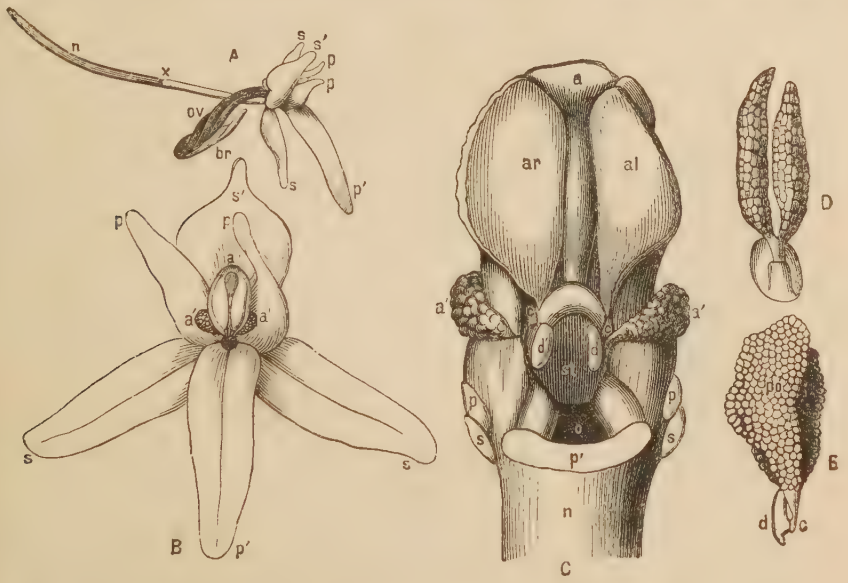


FIG. 372. *Habenaria bifolia*, *R.Br.* (after Herm. Müller). *A*. Flower, seen from the side (almost × 2). *B*. Do., seen directly from the front (× 4). *C*. Reproductive organs and entrance to the spur, seen directly from the front (almost × 16). *D* and *E*. Pollinia and their disks after complete torsion (almost × 16). *a*, anther; *a' a'*, vestigial anthers; *ar* and *al*, right and left anther-lobes; *br*, bract; *c*, caudicle; *d* and *d'*, disks; *n*, nectary (in which secretion rises to ×); *o*, opening of spur; *ov*, ovary; *p p*, upper petals; *p'*, labellum; *s s*, lateral sepals; *s'*, upper sepal; *st*, stigma.

downwards by the contraction of the caudicles, and, clinging to the base of a visitor's proboscis, are brought to the stigma situated between the two disks. A. de Bonis (Riv. fis. mat. sc. nat., Pavia, xiii, 1893) states that the species is sometimes fertilized by means of the wind.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Darwin, Noctuid moths. Rogenhofer, the hawk-moth Sphinx pinastri *L.* (with pollinia on its palps). Heinsius (Holland), 2 moths—Hadena monoglypha *Hfn.* ♂ and ♀, and Plusia gamma *L.* (with pollinia on their palps) (Bot. Jaarb. Dodonaea, Ghent, iv, 1892, pp. 116–17). Scott-Elliot (Dumfriesshire), large moths ('Flora of Dumfriesshire,' p. 168).

2621. H. hyperborea R. Br. (=Platanthera hyperborea *Lindl.*).—Warming describes the flowers of this species as possessing a vanilla odour, and Darwin states that they are regularly self-fertilized.

2622. H. viridis R. Br. (=Peristylus viridis *Lindl.*). (Darwin, op. cit., 43, 63, 255; Herm. Müller, 'Alpenblumen,' p. 72.)—

Visitors.—Probably small moths.

819. Platanthera Rich.

2623. P. chlorantha Cust. (=P. montana *Reichb. f.*; Habenaria chlorantha *Bab.*; and H. bifolia *R. Br.*, according to the *Index Kewensis*). (Darwin, 'Orchids,' p. 69; Herm. Müller, 'Alpenblumen,' p. 72; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 323; Kirchner, 'Flora v. Stuttgart,' p. 171.)—The almost odourless, green flowers of this species are larger than those of Habenaria hyperborea, and the spur is 23–43 mm. long; very rarely, however, flowers entirely without a spur occur. The caudicles of the pollinia are united by small, drum-shaped expansions to the disks, and as these are situated more deeply in the entrance to the spur, the pollinia attach themselves to the eyes of visitors.

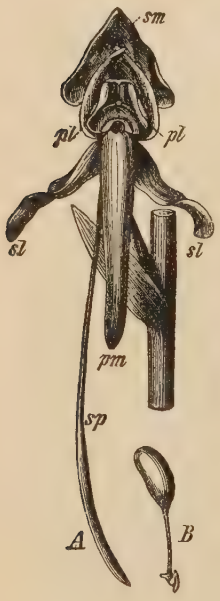


Fig. 373. *Platanthera chlorantha, Cust.* (after Pfitzer). *A.* A flower, seen directly from the front. *pl pl*, lateral petals; *pm*, labellum; *sl sl*, lateral sepals; *sm*, upper sepal; *sp*, spur. *B.* A pollinium, seen from the side.

Visitors.—Darwin observed 2 moths—a Plusia sp., carrying a pollinium on the edge of one eye; and Mamestra dentina *Esp.*, with a pollinium on one eye.

820. Ophrys L.

Partly fly flowers. Frequently automatic self-pollination. Inflorescences unilateral in consequence of twisting of the ovaries.

2624. O. muscifera Huds. (= O. myodes *Jacq.*). (Darwin, op. cit., p. 45; Herm. Müller, 'Weit. Beob.,' I, pp. 285–91; Kirchner, op. cit., p. 172.)—The elongated, velvety labellum in this species is blackish-purple in colour, marked with an almost square, glabrous, pale-bluish central patch; it secretes small drops of nectar down the middle in a longitudinal furrow for a short time immediately after the flower opens; later on there is merely a thin, shining, damp layer, which disappears immediately. A button-shaped process, with an almost metallic gleam, situated on each side of the base of the labellum, serves as a further attraction. It seems, therefore, that the fly flower is a deceptive one adapted to the visits of carrion-flies.

Visitors.—Herm. Müller observed Sarcophaga; insect-visits, however, are so few, that the flowers generally remain unpollinated. The same observer also saw a fossorial wasp (Gorytes mystaceus *L.*) on a flower, without obtaining anything, however, or removing pollinia.

2625. O. apifera Huds. (Robert Brown, Trans. Linn. Soc., London, xvi, 1833; Ridley, J. Linn. Soc. Bot., London, xxiv, 1888; Darwin, op. cit., p. 52; Kirchner, op. cit., pp. 172–3.)—The dark-brown, velvety labellum of this species possesses a yellowish marking, and at the base there is a crescent-shaped, purple-brown patch. Insect-visits must be very rare, for none have yet been observed; propagation is therefore effected by automatic self-pollination, the pollinia on their very long caudicles hanging out of the anther-loculi soon after the flower opens, and sinking so far down that they touch the stigma. Darwin states that autogamy is entirely effective.

FIG. 374. *Ophrys apifera, Huds.* (after Darwin). *A.* Side view of flower, with the upper sepal and the two upper petals removed. One pollinium, with its disk still in its pouch, is represented as just falling out of the anther; and the other has fallen almost to its full extent, opposite to the hidden stigma (enlarged). *a*, anther; *ll*, labellum. *B.* Pollinium in the position in which it lies embedded (still further enlarged).

2626. O. arachnites Lam. (Darwin, op. cit., p. 51; Eckstein, 'Eigent. Befrucht. b. Ophrys arachnites'; Cromans, Just's bot. Jahresber., Leipzig, (1884) 1886, p. 682.)—Eckstein and Cromans say that this species also is propagated by means of automatic self-pollination. Eckstein states that the pollinia possess rather long caudicles, coiled like a lepidopterid proboscis, and attach themselves firmly to the stigma, when the spirals unroll.

2627. O. oestrifera Bieb. (=O. cornuta Stev.).—Kerner says that in this species the two hollow cones situated on the upper lip serve as supports for insect visitors.

I have watched numerous species of Ophrys on the island of Capri, but have never seen insects visit them; Appel says the same of O. Bertolonii *Moretti* and O. arachnites *Lam.* in the neighbourhood of Riva and Gargnano on Lake Garda.

821. Herminium L.

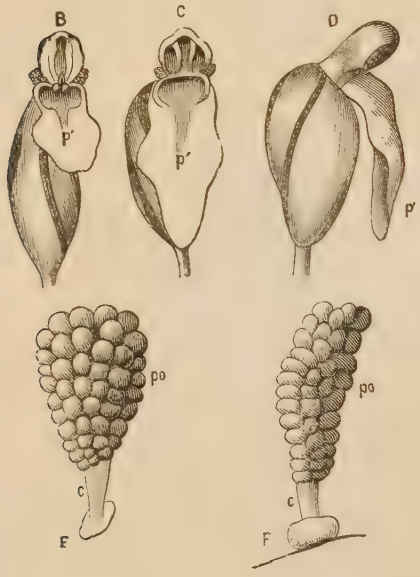
Small-insect flowers.

2628. H. alpinum L. (=Chamaeorchis alpina *Rich.*, and Ophrys alpina *L.*). (Herm. Müller, 'Alpenblumen,' pp. 73–5.)—Herm. Müller supposes that the small, odourless, greenish-yellow flowers of this species are visited and crossed by small ichneumon-flies and minute flies or beetles. He also states that automatic self-pollination is rendered difficult.

VISITORS.—*Vide supra.*

2629. R. Monorchis R. Br. (= Ophrys Monorchis *L.*). (Darwin, op. cit., p. 59; Herm. Müller, 'Alpenblumen,' pp. 72–3; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 256.)—The flowers of this species are adapted for pollination by small insects or ichneumon-flies (cf. Vol. I, p. 137). They are small and greenish-yellow in colour, with a strong odour of nectar.

Visitors.—George Darwin saw minute Hymenoptera (particularly Tetrastichus diaphanthus *Walk.*), flies and beetles (Malthodes brevicollis *Payk.*). Herm. Müller observed dwarf ichneumon-flies. The pollinia cling to the joints of one of the fore-legs of the insects, and, after having bent downwards, are pressed against the stigma of a flower visited later.



822. **Aceras** R. Rr.

As Orchis.

2630. A. anthropophora R. Br. (=Ophrys anthropophora *L.*). (Darwin, op. cit., p. 26.)—Darwin states that the flower mechanism of this species agrees essentially with that of Orchis mascula and its allies.

823. **Epipogum** S. G. Gmel.

Bee flowers.

2631. E. aphyllum Sw. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 226, 257; Rohrbach, 'Epipogium.')—The flowers of this species possess a vanilla-odour, and the perianth is yellowish in colour with a flesh-red spur. The labellum is arched

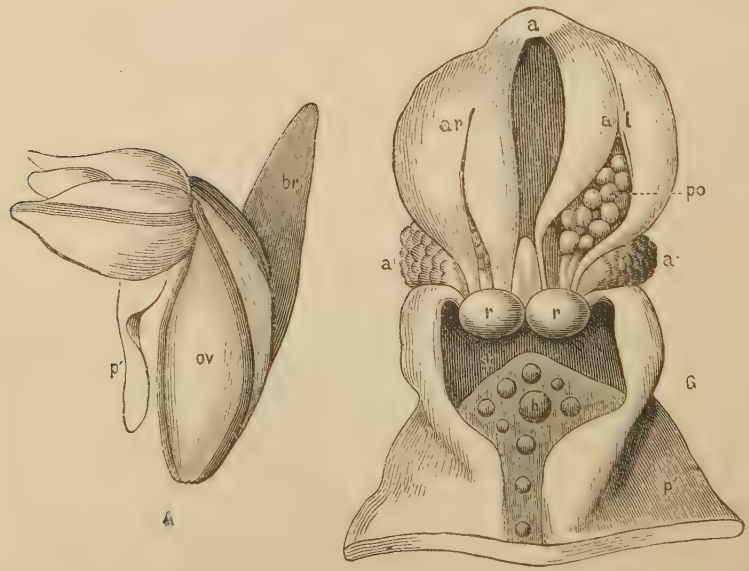


Fig. 375. *Herminius alpinum*, *Lindl.* (after Herm. Müller). *A*. Side view of a flower that has been over for a considerable time. *B*. A young flower after removal of all the perianth leaves except the labellum, seen directly from the front. *C*. A somewhat older flower, which has already lost its pollinia. *D*. A still further developed flower, seen from the side (× 7). *E* and *F*. Pollinia, seen from the front and from the side. *G*. The middle of a young flower, seen from the front (× 35). *a*, anther; *a'a'*, vestigial anthers; *ar* and *al*, right and left anther-lobes; *br*, bract; *c*, caudicle; *h*, nectar; *ov*, ovary; *p'*, labellum; *po*, pollinium; *r r*, rostellum; *st*, stigma.

like a helmet, directed upwards, and secretes nectar on its inner side. The five other downwardly directed perianth leaves are long, narrow, and slightly bent upwards, thus enclosing a space, in the middle of which the column consisting of stigma and anther is situated; this slopes gently upwards and forms an alighting-platform. Kerner states that humble-bees probing for nectar touch this platform with the under-side of their bodies in climbing upwards over it. On the downwardly directed end of the column are situated first the anther, next the rostellum, with very sticky papillae, and finally, still higher up, the stigma, forming a steep wall. The ovoid pollinia are united to the sticky papillae of the rostellum by long, tough threads, and covered by a membranous cap belonging to the anther. The wood humble-bee (Bombus lucorum *L.*) found in shady woods, uses the column as an alighting-platform, and from its lower edge probes for nectar in the galeate labellum; it does not immediately come into contact with the concealed pollinia, but the sticky papillae of the rostellum adhere to the under-side of its body. When the insect leaves the flower, the cap covering the pollinia springs back, so that the two pollinia clinging to the disks are torn out and carried away. At the same time they turn over, so that they now hang downwards from their caudicles like two cherries on their stalks. The whole of the structure thus torn out elongates somewhat, so that the pollinia can be deposited on the stigma of another flower. The stigma is situated above the rostellum, and if the pollinia did not possess long caudicles, they could not be pressed on it by humble-bee visitors.

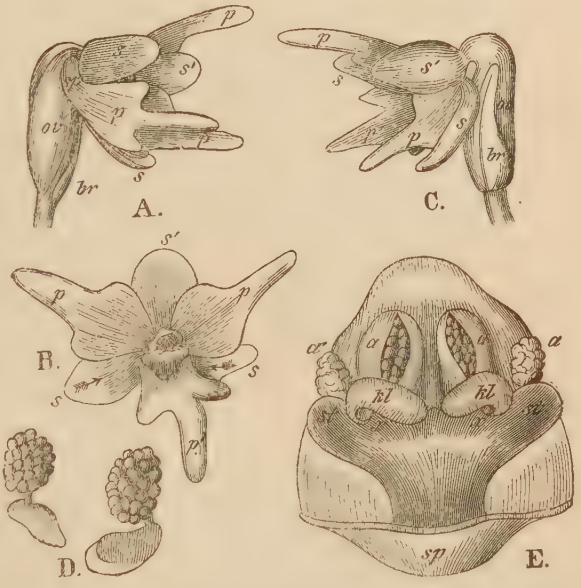


FIG. 376. *Herminium Monorchis*, *R. Br.* (after Herm. Müller). *A.* Flower, seen from the side. *B.* Do., from the front, with the perianth leaves forcibly separated. *D.* Do., in the natural position, seen from the side (× 7). *D.* Pollinia. *E.* Reproductive organs and base of labellum (× 32). *a a*, anther-lobes; *a' a'*, vestigial anthers; *br*, bract; *kl kl*, disks; *ov*, ovary; *p p*, lateral petals; *p'*, labellum; *s s*, lateral sepals; *s'*, upper sepal; *sp*, spur; *st*, stigma: *x x*, recesses below disks; the arrows in *B* indicate lateral accesses to spur.

Rohrbach, who has described the flower-mechanism very minutely, states that the spur and the upper margin of the labellum serve as an alighting-platform for the insect, whence it creeps on to the labellum round its tip. It then reaches the downwardly directed perianth leaves, raises it head, and clings comfortably to the labellum, with the intention of emptying the nectary, and bores into the inner surface of this to suck out the juice. When leaving the flower, the insect must climb down the downwardly directed column, and thus strikes against the rostellum, causing its epidermis

to burst, when the mucilage exudes. This fixes the caudicles to the fore-part of the insect's head, so that the pollinia are drawn out of their recesses. In order to prevent tearing of the pollinia, which are firmly surrounded by the anther lobes, the original tip of the anther is situated on the rostellum. When the insect has come into contact with the epidermis of the latter, and the caudicles have become fastened to its head by means of the sticky exuding secretion, it immediately strikes against the tip of the anther in raising itself erect. This is thus slightly raised, forming a broader cleft, wide enough for the pollinia to be drawn out uninjured. As the insect leaves the flower immediately after removing the pollinia, an extremely rapid hardening of the adhesive liquid is necessary in order that they may not be torn from the insect's head as it flies.

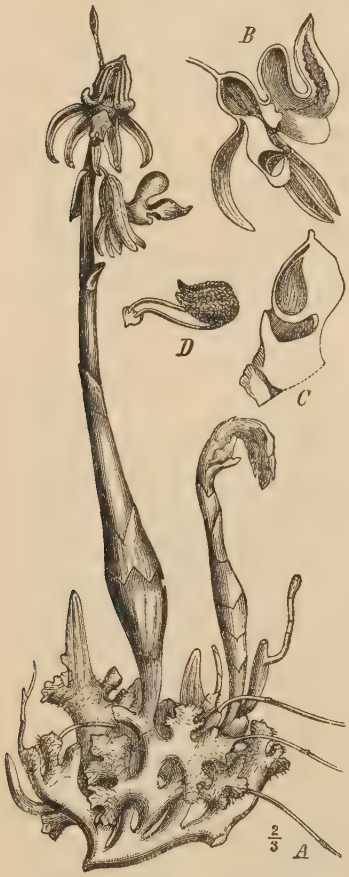


FIG. 377. *Epipogum aphyllum*, *Sw.* (after Pfitzer). *A*. Entire plant. *B*. Flower in longitudinal section. *C*. Column in longitudinal section. *D*. Pollinia.

Both pollinia are usually removed simultaneously by the visitor; should one, however, remain in its recess, pollination is not prevented, as a small part of a pollinium is enough to effect it. The pollinia cling between the eyes and the forehead of the insect; their caudicles are extremely slender, and are drawn down by the weight of the pollen until they lie flat on the insect's head, the pollinia thus projecting forward like a pair of club-shaped feelers. On visiting another flower, the insect bends its head slightly outwards towards the nectary and brushes against the projecting stigma, so that a part of the pollinia remains clinging to it and pollination is effected.

824. Limodorum L.

2632. L. abortivum Sw. (=Orchis abortiva *L.*). (Pedicino, Rend. Acc. sc., Napoli, xiii, 1874, pp. 118–20; Freyhold, Verh. bot. Ver., Berlin, xix, 1877, pp. 23–8.)—Pedicino states that automatic self-pollination takes place regularly in this species. On a garden specimen Freyhold observed only closed flowers, which, however, were otherwise normal in form and colour; these fertilized themselves and also set abundant fruits. The plants growing wild in the neighbourhood of Freiburg i. B. seemed to behave similarly. On this plant, which is remarkably rich in pollen,

Freyhold frequently observed the presence of supernumerary stamens, sometimes belonging to the inner, and sometimes to the outer staminal whorl.

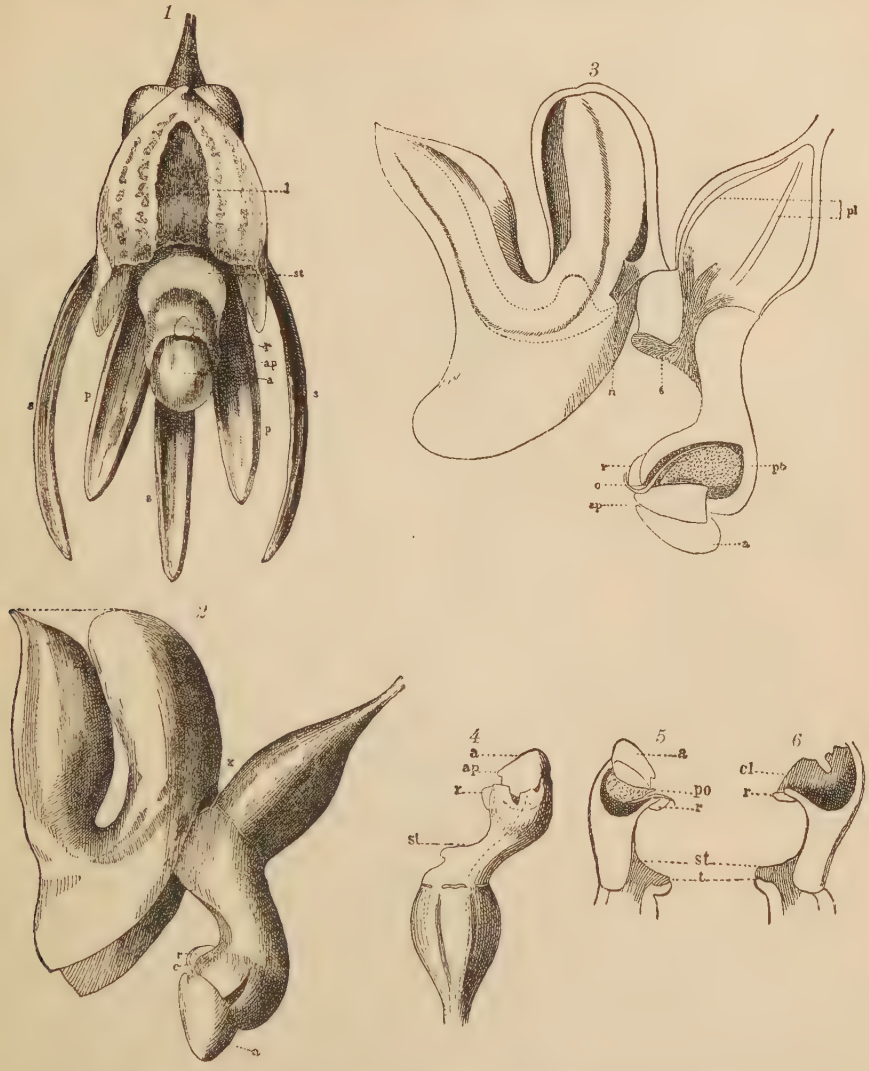


FIG. 378. *Epipogum aphyllum*, *Sw.* (after P. Rohrbach). (1) Flower, seen from the front. (2) Do., from the side, after removal of the helmet. Insects creep down on the line between spur and labellum (× 4½). (3) Longitudinal section of a flower. The ovules have been removed from the ovary. The ridge at the base of the spur is cut through. Vascular bundles are indicated by dotted lines (× 5). (4) Column and ovary of an open flower. (5) Do., in longitudinal section. (6) Do., after removal of the anther (× 10). *a*, anther; *ap*, tip of do.; *c*, caudicle; *cl*, clinandrum; *l*, labellum; *n*, nectary; *p*, petal; *pl*, placenta; *po*, pollinium; *r*, retinaculum; *s*, sepal; *st*, stigma; *t*, conducting tissue; *x*, true nectary.

825. **Cephalanthera** Rich.

2633. C. pallens Rich. (= C. grandiflora *S. F. Gray*). (Darwin, op. cit., p. 80; Kirchner, 'Flora v. Stuttgart,' p. 174; Ridley, J. Linn. Soc. Bot., London,

xxiv, 1888.)—Darwin, Ridley, and Kirchner describe the flowers of this species as autogamous. The pollen is loose and friable. The single grains are almost entirely separate from each other and are only united by a few threads. The anthers dehisce before the flower opens, when the pollinia fall on the upper margin of the stigma situated below them, so that automatic self-pollination takes place. Cross-pollination by means of insects is, however, possible. In this case the anterior part of the labellum, bent at right angles to the rest, serves as a platform for them. The visitor then scatters the pollen broadcast into the upright flower, gets dusted with it, and may transfer it to the stigma of another blossom. After pollination has taken place, the terminal lobe of the labellum erects itself and closes the entrance to the flower.

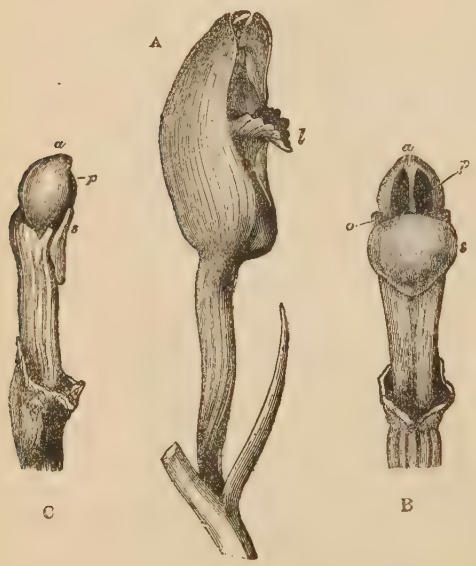


FIG. 379. *Cephalanthera pallens, Rich.* (after Darwin). *A*. Flower, seen obliquely from the front. *B*. Column seen from the front after removal of all the perianth leaves. *C*. Do., from the side: a pollinium can be seen above between anther and stigma. *a*, anther; *l*, terminal lobe of labellum; *o*, vestigial anther; *p*, pollinia; *s*, stigma.

2634. C. ensifolia Rich. (=C. xiphophylla *Reichb. f.*). (Kirchner, 'Beiträge,' pp. 10–11; Delpino, 'Ult. oss.,' II, p. 149.)—The white flowers of this species possess a yellow-brown patch at the tip of the labellum, which is continued behind by several ridges of the same colour, running down into the flower base. Nectar is probably secreted in the sacculated posterior part of the labellum. The anterior part of the labellum, of which the edges are turned upwards, can be easily pressed down, and it then springs back into its original position by elasticity. Delpino therefore concludes that this species can only be pollinated by means of insects, and describes the manner somewhat as follows:—The column is so bent downwards in the mouth of the flower, that the visitor, backing out to fly away, smears a short length of its back and head with the abundant tenacious mucilage of the stigma. The part thus covered comes into contact immediately with the pollinia, fastening them firmly to it. When the insect visits another flower, a part of these pollinia is deposited on the stigma. It is easy to imitate this proceeding: if one touches the stigma with a needle, some of the stigmatic mucilage adheres to it, and if the pollinia are immediately touched with it, they cling sufficiently firmly. If they are then brought into contact with the stigma of the same or another flower, they remain adhering to it. Insect visitors obviously bring about the pollination of this species in a similar manner. That insect-visits are adequate appears from the fact that in many spikes all the pollinia are removed. Automatic self-pollination seems to be excluded.

2635. C. rubra Rich. (Kirchner, 'Neue Beob.,' p. 12, 'Beiträge,' p. 12, 'Flora v. Stuttgart.')—The mechanism of the beautiful purple-red, rarely white flowers of this species agrees essentially with that of C. pallens. The anterior expanded part of the labellum, serving as a platform for insects, is however longer than in that species. The reddish pollinia are situated on the posterior margin of the stigma, and free themselves from the loculi. The stigma is very sticky. Near Ueberlingen, Kirchner observed that the pollinia were removed from many flowers, insect-visits having therefore taken place. Warnstorf describes the pollinia as sessile, but separate to their bases. The pollen-grains are not cemented together, but distinct, and only loosely connected, rounded tetrahedral, pale bluish in colour, tuberculate, on an average 31 μ in diameter.

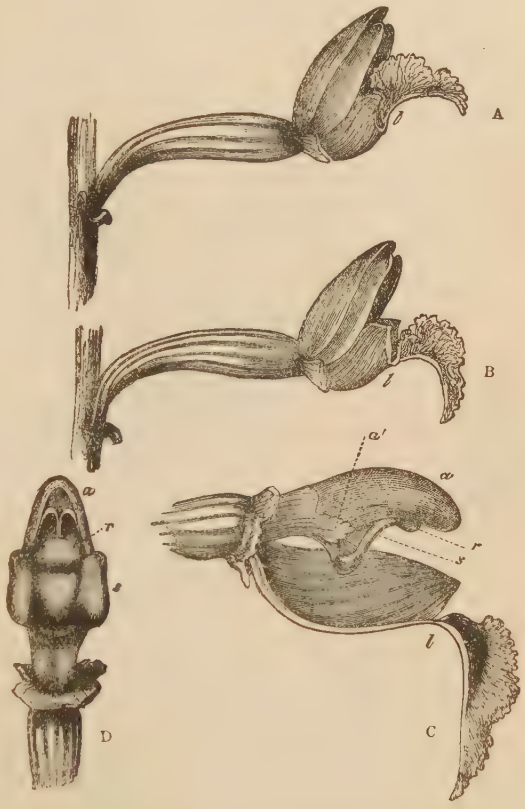


FIG. 380. *Epipactis palustris*, *Crantz* (after Darwin). *A*. Side view of a flower, after removal of the lower perianth leaves. *B*. Do., with the front part of the labellum pressed down in the same way as by an insect visitor. *C*. Flower from the side, after removal of all the perianth leaves except half the labellum (further enlarged). *D*. Column from the front, after removal of all the perianth leaves: the rostellum is actually situated somewhat higher (further enlarged). *a*, anther with its two loculi open; *a'*, vestigial anthers; *l*, labellum; *r*, rostellum; *s*, stigma.

826. Epipactis Rich.

Nectar half-concealed.

2636. E. palustris Crantz. (Darwin, op. cit., p. 93; Kirchner, 'Flora v. Stuttgart,' p. 176; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 324–5.)—In the horizontal flowers of this species, the part of the labellum projecting beyond the other perianth leaves serves as a platform for insect visitors. It is united by a joint to the lower part, which forms a cup containing nectar, is elastic and movable, and somewhat bent upwards. The lower part of the stigma is bilobed; a small, almost globular rostellum projects somewhat above it, and is covered with a soft, elastic cap, viscid internally. This can easily be lifted off by pressure from inside and below. The anther dehisces longitudinally before the flower opens, so that the two sessile pollinia are exposed. Their pollen-grains are united into small packets by elastic threads, and the threads are joined into cords which are fastened to the posterior lobes of the cap covering the rostellum.

Insects alighting on the front part of the labellum press it downwards, so that on

entering the flower they do not touch the rostellum. They only come into contact with this when creeping back, as the lower part of the labellum has sprung upwards again in the meantime. The insects then remove the pollinia on their heads or backs, and on visiting another flower deposit them on the stigma and so effect crossing.

Visitors.—W. E. Darwin (Isle of Wight), beside the honey-bee, which is the regular pollinator, observed flies (Sarcophaga carnaria *L.*, and Coelopa frigida *Fall.*) and a fossorial wasp (Crabro brevis *v. d. L.*).

2637. E. latifolia All. (Darwin, op. cit., p. 100; Kirchner, 'Flora v. Stuttgart,' p. 177; MacLeod, loc. cit.; Kerner, 'Nat. Hist. Pl.' Eng. Ed. 1, II, pp. 253–5; Webster, 'Fertlsn. of Epipactis latifolia'; Knuth, 'Bloemenbiol. Bijdragen.')—This species bears wasp flowers. It occurs in two forms: (*a*) *viridans* Crantz, with a broad, ovo-cordate, reddish-violet labellum, the raised parts of which are smooth, or slightly furrowed, or altogether absent; (*b*) *varians* Crantz (= E. viridiflora *Reichb.*), with an ovate labellum, reddish in colour with white spots, of which the raised parts are indistinct, usually smooth, and sometimes absent. Both forms possess the same flower mechanism, corresponding exactly to that of the type species. The terminal lobe of the labellum, however, is smaller, and possesses no joint, but is fastened firmly to the basal region. In correspondence with this the rostellum projects still further beyond the stigma. Automatic self-pollination is therefore excluded, but Webster says that insect visitors effect self-pollination more frequently than crossing.

Fig. 381. *Epipactis latifolia*, *All.* (after Darwin). Flower from the side, after removal of the perianth leaves, except the labellum (enlarged). *a*, anther; *l*, labellum; *r*, rostellum; *s*, stigma.

Visitors.—These are almost entirely wasps:—Darwin records Vespa sylvestris *Scop.*; Kerner, V. austriaca *Pz.*; and Knuth, V. vulgaris *L.*; Loew (Brandenburg, 'Beiträge,' p. 42) V. rufa *L.*, ♀, skg. Webster observed humble-bees as well as wasps. Gerstäcker (central mountains of Germany) and Schletterer (Tyrol) saw Bombus hortorum *L.*

Hermann Müller asserts ('Fertlsn.,' p. 532) that E. viridiflora *Reichb.* (=E. latifolia *All.*, var. (*a*) varians *Crantz* (*cf.* Max Schultze, 'D. Orchid. Deutschlands, Deutsch-Oesterreichs u. d. Schweiz,' Gera, 1894) has entirely lost the advantages of a viscid rostellum; only minute pollen-clumps can occasionally be carried away by small insects on this account, and autogamy consequently takes place to a still larger degree than in the next species (E. microphylla).

2638. E. microphylla Sw. (Darwin, op. cit., p. 102; Herm. Müller, 'Fertlsn.,' p. 532.)—Self-pollination takes place regularly in this species, though crossing may also be effected by insects, a part of the pollen adhering to the visitor by means of the mucilage contained in the rostellum.

2639. E. atrorubens Schult. (= E. rubiginosa *Crantz*). (Ridley, J. Linn. Soc. Bot., London, xxiv, 1888; Knuth, 'Blütenbiol. Beiträge.')—The flowers of this species are dark purple-red in colour, and possess a vanilla-odour with an accessory fragrance of pinks. Like those of the two preceding species, they possess a cap over the rostellum which can easily be removed by a light pressure from below, as I found from numerous examples on the Dunes of Usedom. At the time (in 1883), however, I made no further notes; I also observed no visitors then. Ridley states that the plant is autogamous, pollen-tubes growing directly from the pollinia into the stigma.

827. Serapias L.

2640. S. longipetala Pollini. (Delpino, 'Applicaz. d. teor. Darwin.')—Visitors.—Delpino observed bees in Liguria.

2641. S. occultata J. Gay. (Nicotra, Malpighia, Genova, i, 1887, pp. 460–3.)—Nicotra says that this is autogamous, but heterogamy is not excluded.

2642. S. Lingua L.—In this species autogamy is rendered very difficult by the position of the pollinia, as the falling pollen cannot reach the stigma. Both this species and the previous one resemble Epipactis to some extent in their flower mechanism.

828. Listera R. Br.

Nectar exposed.

2643. L. ovata R. Br. (Sprengel, 'Entd. Geh.,' pp. 406–11; Darwin, op. cit., p. 115; Herm. Müller, 'Fertlsn.,' p. 295; MacLeod, Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 309–10, v, 1893, pp. 326–8; Kirchner, 'Flora v. Stuttgart,' p. 178.)—

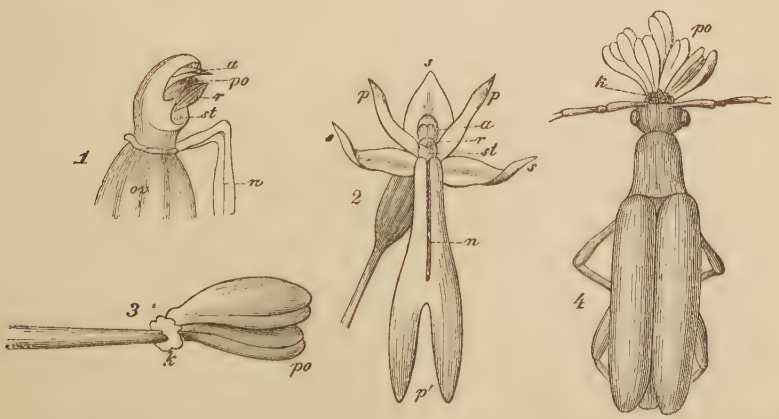


FIG. 382. *Listera ovata*, *R. Br.* (after Herm. Müller). (1) Part of a virgin flower, seen from the side. (2) Flower from the front, after the pollinia have been removed from the anther and the foliate rostellum has bent over and partly covered the stigma (on half the scale of (1)). (3) The pollinia attached to a needle (× 20). (4) A specimen of Grammoptera laevis with numerous pollinia attached to the front of its head. *a*, anther; *k*, viscid matter; *n*, nectar-groove; *ov*, ovary; *pp*, lateral petals; *p'*, labellum; *po*, pollinia; *r*, rostellum; *ss*, sepals; *st*, stigma.

This species bears ichneumon-fly flowers (*cf.* Vol. I, p. 121). They are inconspicuous and greenish-yellow in colour, possessing a long, nectar-secreting groove in the

middle of the long, narrow, downwardly curved labellum. The large, thin, leaf-like, pointed rostellum contains mucilage, which exudes in white, tenacious drops at the slightest touch. The anther situated behind the rostellum dehisces while the flower is still in the bud, so that when it opens the pollinia are freely exposed, lying on their backs with their apices converging to the upper end of the rostellum, which then curves slowly over the stigmatic surface.

The smaller visitors, consisting largely of ichneumon-flies, use the lower end of the labellum as an alighting-platform, creep slowly upwards, licking all the nectar out of the groove from the bottom to the top, and ultimately strike their head against the rostellum, which immediately exudes two small, white drops of mucilage. These run together and fasten on one hand to the side of the head and on the other to the tips of the pollinia, so that the latter are carried away by the visitor. During this process, the rostellum curves quite over the stigma, thus preventing autogamy. It then moves slowly back, leaving the stigma once more exposed. In the meantime this has become very sticky, and the emptied nectar-groove again fills with nectar. Should the insect now visit a flower from which the pollinia have already been removed, the stigma is struck by the pollinia, part of which adhere to it. Crossing is therefore always effected, and usually between separate stocks.

Warnstorf describes the pollen-grains as united into tetrads, and 50–6 μ in diameter.

Visitors.—The following were recorded by the visitors, and for the localities stated.—

Sprengel saw 'a small beetle with black head and scutellum and brown elytra, which had taken such a head-adornment (pollinia) from a flower.' This was apparently the regular visitor Grammoptera laevis *F.* He also repeatedly observed an ichneumon-fly 'bearing a pair of pollen-clubs in its head.' Herm. Müller saw Braconids and Ichneumonids effect pollination. Kaltenbach identified these as—(*a*) *Braconidae*: 1. Alysia sp., one; 2. Microgaster globata *L.*, var. rufipes *Nees*; (*b*) *Ichneumonidae*: 3. Campoplex sp., one; 4. Cryptus, 8 individuals of 3 sp.; 5. Amblyteles uniguttatus *Grav.*, one; 6. Phygadenon sp., 2; 7. Tryphon sp., 2. Müller also observed the humble-bee Bombus agrorum *F.*, nect-lkg., but not removing pollinia. MacLeod (Belgium), a bee (Andrena sp.), 2 other Hymenoptera, and a beetle. Plateau (Belgium), the hover-fly Melanostoma mellina *L.*; (Pyrenees), the beetle Rhagonycha fulva *Scop.* (= R. melanura *F.*), nect-lkg. (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 309). Darwin (England), 2 ichneumon-flies (Hemiteles sp., and Cryptus sp.) with pollinia attached to the front of the head.

2644. L. cordata R. Br. (Darwin, op. cit., p. 124.)—Darwin describes the flower mechanism of this species as agreeing essentially with that of L. ovata.

Visitors.—Darwin says there are small Diptera and Hymenoptera.

829. Neottia L.

Flowers with exposed to half-concealed nectar.

2645. N. Nidus-avis Rich. (= Ophrys Nidus-avis *L.*). (Herm. Müller, 'Fertlsn.,' p. 531; Darwin, op. cit., p. 125; Kirchner, 'Flora v. Stuttgart,' p. 179; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 195; Loew, 'Blütenbiol. Floristik,' p. 344.)—Kerner says that the pale yellow-brown colouring of the plants of this

species is enough to bring them out in relief against the dark ground of the wood, thus rendering them conspicuous. Loew objects to this that the colouring resembles

FIG. 383. *Neottia Nidus-avis, Rich.* (after Herm. Müller). (1) Flower, seen from the side. (2) Side view of the labellum. (3) Front view of do.; the small circles represent drops of nectar. (4) The column, seen from the side. *a*, anther; *br*, bract; *co*, corolla; *ov*, ovary; *p*, lateral petal; *p'*, labellum; *po*, pollinium; *r*, rostellum; *s*, sepals; *st*, stigma.

that of the dead leaves, and the plant therefore is often difficult to distinguish among them. In his opinion the colouring is less for display than for protection.

The flower mechanism agrees essentially with that of Listera ovata, but the nectar is concealed in a labellum which forms a shallow bowl, and is therefore not quite so exposed as in Listera. Also the pollinia adhere less completely and securely. If insect-visits fail, therefore, automatic self-pollination frequently takes place, the very crumbling pollen falling automatically upon the stigma.

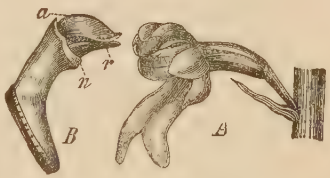


FIG. 384. *Neottia Nidus-avis, Rich.* (after Herm. Müller). *A*. Flower. *B*. Column. *a*, anther; *n*, stigma; *r*, rostellum.

VISITORS.—Herm. Müller observed a nect-lkg. fly (Helomyza affinis *Mg.*), which took up pollen in the most anterior part of its thorax.

830. Spiranthes Rich.

Nectar concealed.

2646. S. autumnalis Rich. (= Ophrys spiralis *L.*). (Darwin, op. cit., p. 106; Kirchner, 'Flora v. Stuttgart,' pp. 180–1.)—The small, whitish, horizontal flowers of this species possess an odour of hyacinths. The reflex part of the labellum serves as a platform for visitors, which find two globular nectaries on the lower part of the organ, their abundant secretion being collected in a small receptacle situated below them. The access to this is rendered very narrow by the nectaries and the projecting margin of the stigma. The rostellum, forming a long, thin, narrow process, is united with the stigma by two diverging shoulders. The middle part of the posterior side of the rostellum forms a somewhat elongated receptacle for mucilage. A longitudinal line on the anterior side is slightly hollowed over the middle of this receptacle. Slight contact ruptures this anterior side longitudinally, so that some mucilage exudes. The slit then extends to the back of the rostellum,

and the cavity of the anther is exposed. Each loculus contains two very crumbling pollinia, which are separated above, and united in the middle by elastic threads.

The upper part of the loculi, pressed against the back of the rostellum, dehisces before the flower opens, the pollinia thus coming into contact with the back of the mucilage-receptacle. The oblique surface of the stigma projects below the rostellum. Darwin observed humble-bees as visitors; the mucilage-receptacles with the adherent pollinia cling to their proboscides; thus only the lateral, furcate parts of the rostellum were left. After the flower has been open one or two days, the labellum moves away a little from the rostellum, thus widening the approach to the stigma, which is now encountered by humble-bees bringing pollinia. Not only crossing of separate flowers, but usually also of separate stocks is thus effected, as humble-bees are in the habit of sucking nectar from the inflorescence from below upwards.

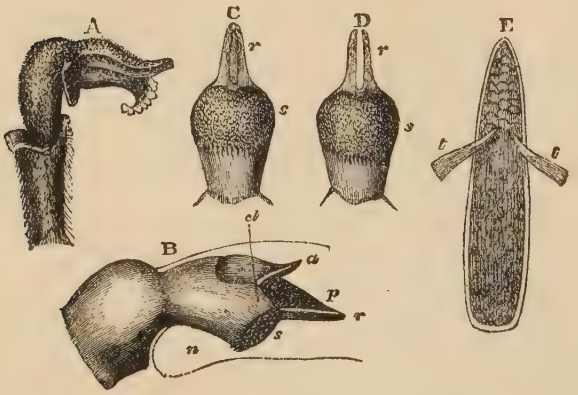


FIG. 385. *Spiranthes autumnalis*, *Rich.* (after Darwin). *A.* Lateral view of a flower, after removal of the two lower perianth leaves; the labellum is fringed anteriorly. *B.* Do., enlarged still more, after removal of all the perianth leaves. The position of the labellum and the upper sepal is indicated by dotted lines. *C.* Stigma and rostellum, with the embedded, central, boat-shaped disk, seen from the front. *D.* Do., after removal of the disk. *E.* Disk, removed from the rostellum, greatly enlarged, viewed posteriorly, with the attached elastic threads of the pollinia; the pollen-grains have been removed from the threads. *a*, anther; *cl*, edge of clinandrum; *n*, nectar receptacle; *p*, pollinia; *r*, rostellum; *s*, stigma; *t*, threads of the pollinia.

831. Goodyera R. Br.

Nectar concealed.

2647. G. repens R. Br. (=Satyrium repens *L.*). (Darwin, op. cit., p. 103; Herm. Müller, 'Alpenblumen,' pp. 75–7; Kirchner, 'Flora v. Stuttgart,' pp. 179–80.)—The horizontal flowers of this species are small, whitish in colour, and feebly fragrant: they are united into unilateral spikes of about 20 flowers. The shield-shaped, almost square rostellum projects a little beyond the stigma. On being lightly touched the surface of this projection exudes mucilage, and is easily pressed upwards, when it carries with it a membranous strip to the posterior end of which the pollinia adhere.

The anther-lobes dehisce while still in the bud, the pollinia clinging with their anterior sides to the back of the rostellum, and being thus almost entirely exposed. The posterior, excavated part of the labellum contains nectar; the anterior grooved part is bent downwards and serves as a platform. In consequence of the narrowness of the entrance to the stigma between the labellum and the rostellum, the proboscis of an insect probing for nectar strikes against the latter and removes the pollinia.

When the insect visits a somewhat older flower, in which the labellum has moved away a little from the column, the pollinia are brought into contact with the stigma.

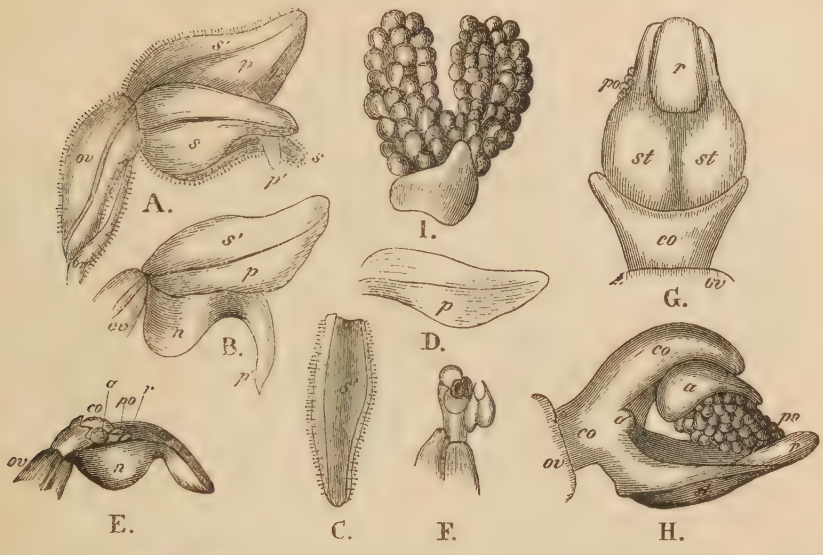


FIG. 386. *Goodyera repens*, *R. Br.* (after Herm. Müller). *A*. Flower, seen from the side. *B*. Do., after removal of the two lateral sepals and the glandular hairs. *C*. Inner surface of the upper sepal. *D*. Exterior of the right petal. *E*. Reproductive organs and labellum, in their natural position, seen from the side. *F*. Reproductive organs, after removal of the pollinia and mucilage (× 7). *G*. Stigma and rostellum, seen from below. *H*. Lateral view of the reproductive organs (× 24). *I*. Pollinia with mucilage, seen from below (× 35). *a*, anther; *a'*, vestigial do.; *co*, corolla; *n*, nectar receptacle; *ov*, ovary; *p*, lateral petals; *p'*, labellum; *po*, pollinium; *r*, rostellum; *s*, lateral sepals; *s'*, upper sepal; *st*, stigma.

VISITORS.—So far only humble-bees have been observed, e. g. Bombus pratorum *L.*, by R. B. Thompson (North Scotland), and B. mastrucatus *Gerst.*, by Herm. Müller (Alps). The latter is inclined to think, however, that the true pollinators are small short-tongued insects, to which the structure of the flowers is adapted.

832. **Corallorrhiza** Hall.

Nectar concealed.

2648. C. innata R. Br. (=Ophrys Corallorrhiza *L.*). (Herm. Müller, 'Alpenblumen,' pp. 77–8.)—The flowers of this species are greenish-yellow in colour with a white labellum, and are dotted with dark-red in the throat. It may be concluded from their small size that they are visited by small insects, which use the anterior downwardly bent part of the labellum as an alighting-platform, and creep thence to the nectar secreted and concealed at the steeply downwardly bent base of this organ. In doing so they strike against the projecting rostellum, remove the clinging pollinia on their upper-side and transfer them to another flower.

833. **Malaxis** Soland.

Small, inconspicuous, insect flowers.

2649. M. paludosa Sw. (=Ophrys paludosa *L.*). (Darwin, op. cit., p. 129.)—The labellum of the small, inconspicuous, greenish flowers of this species serves

as an alighting-platform, and is directed upwards in consequence of the twisting of the ovary. Its lower margin surrounds the column, so that a tube-shaped flower-entrance

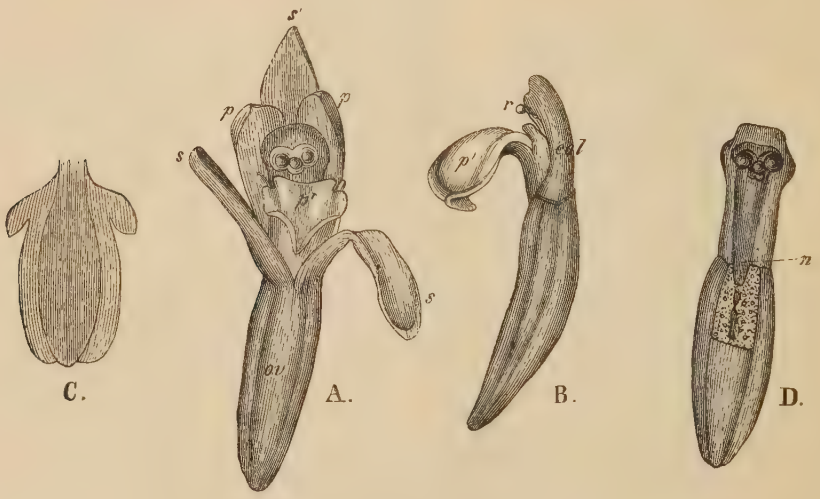


FIG. 387. *Corallorrhiza innata*, *R. Br.* (after Herm. Müller). *A*. Flower, seen from the front. *B*. Side view of do., after removal of all the perianth leaves except the labellum. *C*. Labellum spread out. *D*. Front view of ovary and column, after removal of all the other parts. *col*, column; *n*, nectary; *ov*, ovary; *p p*, lateral petals; *p'*, labellum; *r*, rostellum; *s s*, lateral sepals; *s'*, upper sepal.

is formed. The stigma and anthers are partly protected by the position of the labellum. The column is divided into three parts longitudinally. The middle part of the upper half is the rostellum. The upper margin of the lower part of the column projects at the point where it is fastened to the base of the rostellum as a deep fold—the stigmatic hollow—like a vest-pocket. The middle part, the rostellum, is a long membranous projection covered with thin mucilage, and hollowed out slightly at the back; a small, tongue-shaped, viscid mass projects beyond its crest. The column with stigma and rostellum is united on both sides with a green, membranous expansion, arched outside and hollowed inside. These two membranes are connected with the lower ends of the pollinia and form in this way a deep cup to protect the pollen.

The anther dehisces while still in the bud and then shrivels up, so that in the fully open flower the pollinia are fully exposed, with the exception of their broad lower ends, each of which is situated in a little cup. The upper end of the pollinia rests on the crest of the rostellum.

When an insect inserts its proboscis or head into the narrow space between the vertical labellum and the rostellum, it cannot avoid touching the small, projecting viscid mass and carrying away the pollinia which are already firmly fastened to it but are otherwise free. This can be easily seen by experiment. When another flower is visited, the very thin pollinia, which are fastened on the proboscis or head of the insect, are pressed in, and their broad ends force their way into the pocket-like stigma.

In spite of their smallness and inconspicuousness the flowers are extremely

attractive to insects. Darwin always found the flowers of a spike, except one or two immediately below the buds, to have been robbed of their pollinia; he also noticed pollinia on the stigmas of numerous flowers, but was unable to discover visitors.

834. Microstylis Nutt.

Darwin states that the flower mechanism is similar to that of Malaxis.

835. Calypso Salisb.

Perhaps humble-bee flowers.

2650. C. borealis Salisb. (Lundström, Bot. Centralbl., Cassel, xxxviii, 1889, pp. 697–700.)—The flowers of this species possess a vanilla-odour, and are only rarely visited by insects. The pollinia are discoid and unstalked.

Visitors.—Lundström (at Piteaa in Norway) once observed transfer of a pollinium by a humble-bee. He repeatedly failed to produce ripe fruit by artificial pollination. These are but rarely set in the natural way.

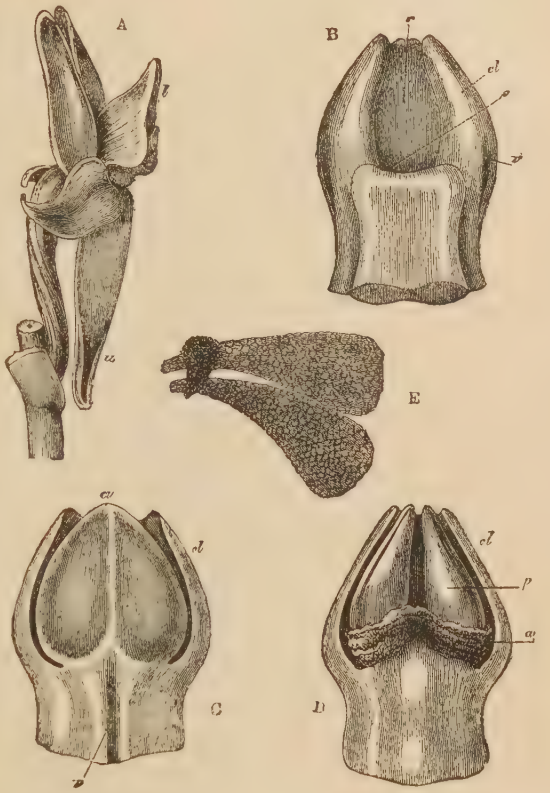


Fig. 388. *Malaxis paludosa*, *Sw.* (after Darwin's figure, which was partly copied from Bauer). *A*. Lateral view of perfect flower, with the labellum in its natural position, upwards. *B*. Front view of column, showing the rostellum, the pocket-like stigma, and the anterior lateral portions of the clinandrum. *C*. Back view of do., from a flower-bud, showing the anther with the included pear-shaped pollinia dimly seen, and the posterior edges of the clinandrum. *D*. Back view of an expanded flower, with the anther now contracted and shrivelled, exposing the pollinia. *E*. The two pollinia, attached to a little transverse mass of viscid matter, hardened by alcohol.

836. Stanhopea Frost.

2651. S. tigrina Batem. (Willis, 'Contrib. to the Nat. Hist. of the Flower,' (2).)—Willis states that the flowers of this species in the Cambridge Botanic Garden are self-fertile.

Visitors.—Willis (Cambridge Botanic Garden) observed the honey-bee, species of Bombus, and hover-flies.

837. Cypripedium L.

Labellum strongly ventricose. The species of this genus are pollinated by bees, flies, and perhaps also by snails.

2652. C. Calceolus L. (Herm. Müller, 'Fertlsn.,' p. 539; Baxter, 'Fertlzn. of Cypripedium'; Webster, Trans. Bot. Soc., Edinburgh, xvi, 1886, pp. 357–60; Darwin, op. cit., p. 226; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 245, 249.)—In flowers of this species the slightly contracted labellum is yellow in colour, and the rest of the perianth leaves purple. This colouring and an odour of nectar attract small bees of the genus Andrena, which creep into the dilated labellum, finding on its under-side juicy hairs which sometimes perhaps also secrete minute drops of nectar; these they lick or gnaw. There are three openings serving as entrances to the cavity of the labellum, one to the right and one to the left of the column, and a wider, oval median one in front of it. Insects choose the latter exclusively as an entrance. When small bees have satisfied themselves in the cavity, they try to get out of it again; the walls

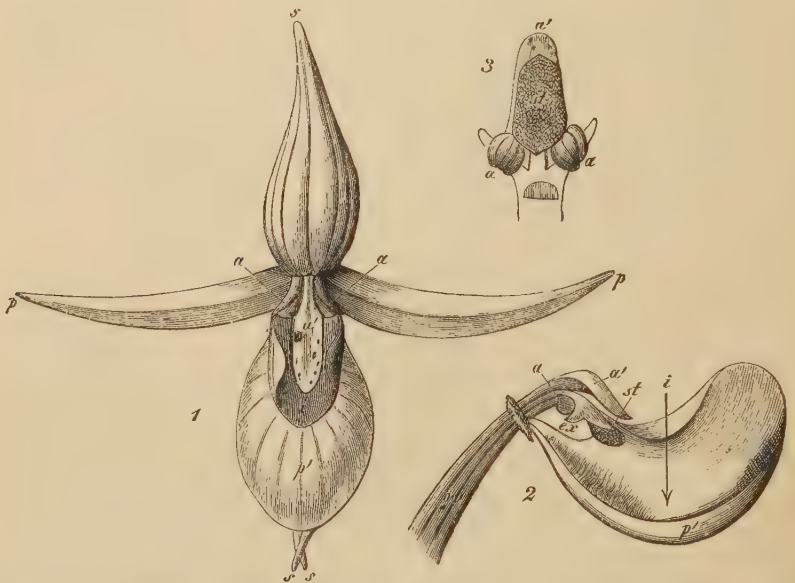


FIG. 389. *Cypripedium Calceolus*, *L.* (after Herm. Müller). (1) Flower, with its parts in the natural position, seen in front and from above. (2) Do., in longitudinal section, after removal of the lateral petals: the labellum is bent slightly downwards, to show the opening *ex* clearly. (3) The reproductive organs from below. *aa*, anthers; *a'*, vestigial anther; *ex*, exit; *i*, entrance; *ov*, ovary; *pp*, lateral petals; *p'*, labellum; *s*, sepals; *st*, stigma.

of their prison, however, are so strongly arched that they cannot escape by the entrance, but finally squeeze themselves, after having crept under the stigma, through one of the two narrow lateral openings. In doing so they brush with one shoulder or the other against the soft, viscous pollen of the anther which forms the inner boundary of the selected exit. In a second flower they deposit the pollen on the broad, rough stigma in creeping under it, while in creeping out of the cavity they take up fresh pollen, so that crossing is regularly effected. The juicy hairs at the base of the labellum make it easier for them to creep out, as they use them as a climbing surface (*cf.* Vol. I, p. 131).

VISITORS.—Herm. Müller gives the following list:—

Five bees—species of Andrena—i.e. 1. A. albicans *Müll.* ♀; 2. A. atriceps *K.* ♀ (=A. tibialis *K.*); 3. A. fulvicrus *K.* ♀; 4. A. nigroaenea *K.* ♀; 5. A. pratensis

Nyl. ♀. The smaller bees are too weak, and the larger flies too bulky to make their escape, and so remain as prisoners. Andrena parvula *K.* ♀ and several flies (Empis punctata *F.*, Cheilosia sp., Anthomyia sp., and Spilogaster semicinerea *Wied.*) were often found dead in the labellum. Small beetles (Meligethes) are often able to creep freely out of the labellum, but sometimes they are held fast by the sticky pollen and remain to perish.

2653. C. barbatum Lindl. (Delpino, 'Ult. oss.,' pp. 176, 229, 'Applicaz. d. teor. Darwin.,' pp. 19–20.)—Delpino says that this species is apparently pollinated by flies, as he found them in the labellum of hot-house specimens, and also observed the setting of fruits there.

838. Selenipedium Reichenb. f.

2654. S. caudatum Reichenb. f. (Delpino, 'Ult. oss.,' p. 177.)—Delpino supposes that this species is pollinated by snails.

839. Angraecum Bary.

2655. A. sesquipedale Thou. (Darwin, op. cit., p. 162; W. A. Forbes, Nature, London, iii, 1873, p. 121.) Darwin says that this species possesses such a long spur that an insect must have a proboscis about 25 cm. long in order to reach the nectar. W. A. Forbes has discovered such an insect.

840. Masdevallia Ruiz et Pav.

2656. M. muscorum Reichb. J. (F. W. Oliver, Ann. Bot., Oxford, i, 1888, pp. 237–53.)—F. W. Oliver states that this species possesses a sensitive labellum, which imprisons the small insect visitor in a cavity, from which it emerges covered with pollen. On visiting another flower it dusts the stigma.

841. Bulbophyllum Thou.

2657. B. macranthum Lindl. (Ridley, 'Ann. Bot.,' Oxford, iv, 1889–91, pp. 327–36.)—Ridley says that this species is pollinated by a small fly.

842. Zygopetalum Hook.

2658. Z. maxillare Lodd.—The flower mechanism of this species is described in detail by an anonymous writer in the Ill. Monatsschr. für d. Gesamtinteressen d. Gartenbaues, ii, and Neubert's D. Garten-Mag., xxxvi, 1883.

843. Nephelaphyllum Blume.

2659. N. pulchrum Blume.—As No. 2658.

844. Dendrobium SW.

2660. D. sanguinolentum Lindl.—As No. 2658. An abstract will be found in Justs bot. Jahresber., Leipzig, xi, (1883) 1885, pp. 492–3.

Darwin describes more or less minutely species of the following genera of other foreign orchids:—

(a) *Epidendrae*: Cattleya *Lindl.*, Epidendrum *L.*, Coelogyne *Lindl.*, Sophronitis *Lindl.*, Barkeria *Knowles et Westc.*, Laelia *Lindl.*, Leptotes *Lindl.*, Phaius *Lour.*, Evelyna *Poepp. et Endl.*, Bletia *Ruiz et Pav.*

(b) *Malaxideae*: Pleurothallis *R. Br.*, Stelis *Sw.*, Masdevallia *Ruiz et Pav.*, Microstylis *Nutt.*, Bulbophyllum *Thou.*, Caleana *R. Br.*, Dendrobium *Sw.*

(c) *Vandeae*: Maxillaria *Ruiz et Pav.*, Aërides *Lour.*, Oncidium, *Sw.*, Rodriguezia *Ruiz et Pav.*, Phalaenopsis *Blume*, Calanthe *R. Br.*, Acropera *Lindl.*, Catasetum *Rich.* (with Myanthus *Lindl.* and Monachanthus *Lindl.*), Mormodes *Lindl.*, Cycnoches *Lindl.*, Sarcanthus *Lindl.*, Galeandra *Lindl.*, Vanda *Jones*, Cymbidium *Sw.*, Trichopilia *Lindl.*, Odontoglossum *H. B. et K.*, Brassia *R. Br.*, Miltonia *Lindl.*, Stanhopea *Frost* (S. devoniensis *Lindl.* is described in an appendix by the German translator G. H. Bronn), Warrea *Lindl.*, Zygopetalum *Hook.*, Lycaste *Lindl.*

(d) *Ophrydeae*: Bonatea *Willd.*

CVIII. ORDER *SCITAMINEAE* R. BR.

(Including Zingiberaceae *Lindl.*, Marantaceae *Lindl.*, Cannaceae *Link*, and Musaceae *Lindl.*)

845. Roscoea Sm.

2661. R. purpurea Sm. (Lynch, J. Linn. Soc., Bot., London, xix, 1892.)—Lynch says that the flower mechanism of this species resembles that of Salvia.

846. Hedychium Koen., and 847. Alpinia L.

Literature.—Delpino, 'Sugli appar. d. fecondaz. nelle piante autocarp.,' p. 22, 'Altri appar. dicog. recent. oss.,' p. 57; Hildebrand, Bot. Ztg., Leipzig, xxv, 1867, p. 277.

In species of these genera lepidopterous visitors touch first the stigma and then the anthers, thus effecting crossing.

848. Zingiber Adans.

2662. Z. officinale Rosc. (Hildebrand, 'Geschlechts-Vert. b. d. Pfl.,' p. 69.)—Hildebrand states that when insects visit the flowers of this species, cross-pollination is ensured by the projecting position of the stigma.

849. Maranta Plum.

The style is held firmly by a hood-shaped perianth leaf on the lower side of the almost horizontal flower, and pollen is deposited on the capitate stigma while still in the bud. When visited by an insect, the style springs out of the hood and bends in such a way that the pollen brought by the insect reaches the stigmatic papillae, and the insect dusts the under-side of its body with fresh pollen.

2663. M. (Calathea) Zebrina Sims, and **2664. M. discolor** Lindl. have been examined by Hildebrand (Bot. Ztg., Leipzig, xxviii, 1870, pp. 617–20).

2665. M. bicolor Ker-Gawl., and **2666. M. cannifolia** have been examined by Delpino.

850. Thalia L.

2667. T. dealbata Fras.—Delpino describes the flower mechanism as similar to that of Maranta.

Visitors.—Delpino observed the honey-bee at Florence.

851. Canna L.

Delpino ('Sugli appar. de fecondaz. nelle piante autocarp.,' p. 23) says that in species of this genus the pollen deposited by the anthers on the stylar disk is removed by insects and transferred to the stigmas of other flowers. Hildebrand (Bot. Ztg., Leipzig, xxv, 1867, p. 277, 'Geschlechts-Vert. b. d. Pfl.,' p. 69) states that automatic self-pollination frequently takes place when the pollen is shed.

852. Strelitzia Ait.

2668. S. Reginae Ait.—In this species insects touch the stigma in alighting, and as they force their way into the flower the two inner, lower petals surrounding the five anthers are pressed apart, and the pollen dusts the under-side of the visitors. A. Wagner (Ber. d. bot. Ges., Berlin, xii, 1894) has treated the anatomy and oecology of the flowers in detail.

Visitors.—Delpino, 'Ult. oss.,' p. 232, 'Applicaz. d. teor. Darwin.,' p. 4; Hildebrand, Bot. Ztg., Leipzig, xxvii, 1869, p. 508, suppose these to be humming-birds, and this is confirmed by Darwin's observations.

CIX. ORDER *HAEMODORACEAE* BENTH. ET HOOK.

Literature.—Pax, 'Haemodoraceae,' in Engler u. Prantl., 'D. nat. Pflanzenfam.,' II, 5, pp. 92–6.

853. Wachendorfia Burm. Wachend.

2669. W. paniculata L.—J. Wilson describes the species as dimorphous (Trans. Bot. Soc., Edinburgh, xvii, 1887, pp. 73–7; Bot. Jaarb. Dodonaea, Ghent, ii, 1890, p. 158).

CX. ORDER *IRIDEAE* JUSS.

In addition to the two brightly coloured perianth whorls the three petaloid stylar branches sometimes serve to increase the conspicuousness of the flowers.

854. Crocus L.

Protandrous lepidopterid flowers.

2670. C. vernus All. (=C. albiflorus *Kit.*, and C. sativus, var. (b) vernus *L.*). (Sprengel, 'Entd. Geh.,' pp. 68–9; Ricca, Atti soc. ital. sc. nat., Milano, xiii, 1870;

Herm. Müller, 'Fertlsn.,' p. 547, 'Alpenblumen,' pp. 56–9; Knuth, 'Bloemenbiol. Bijdragen.')—The plants of this species occur in two forms:—(a) *parviflorus* J. Gay, with smaller, usually white flowers, and stigmas shorter than, or the same length as the stamens; (b) *grandiflorus* J. Gay, with larger, white (or in garden plants violet, heliotrope, or striped) flowers, with stigmas usually longer than the stamens. The first form can therefore pollinate itself towards the end of anthesis, but this only takes place exceptionally in the second form.

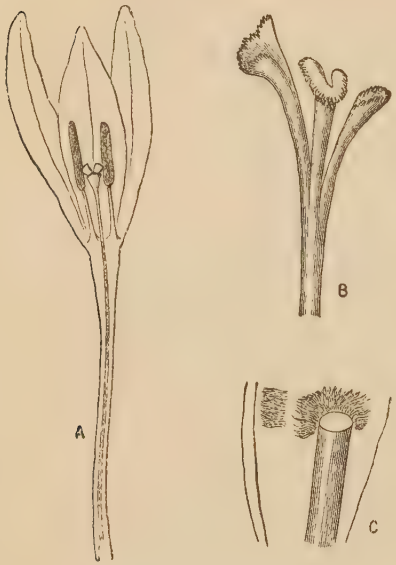


FIG. 390. *Crocus vernus*, *All.* (after Herm. Müller). *A*. Flower after removal of half the perianth (natural size). *B*. The three stigmas. *C*. Section through part of the nectar-cover, and a filament where it becomes separate from the perianth (× 7).

The access to the nectar secreted by the ovary is only possible to the long, thin proboscis of a lepidopterid, as the long, narrow corolla-tube is almost entirely filled by the style. Vertical hairs situated at the place where the filaments diverge, serve to protect the nectar, which fills the tube so far up, that long-tongued humble-bees can suck the uppermost part of it.

The stigmas are at first concealed between the filaments, so that only the pollen-covered anthers are touched by visitors. The stigmas project later on, so that crossing is effected by insect-visits. Should such visits fail, automatic self-pollination takes place. Kerner says that the anthers turn outwards towards the end of anthesis, while the perianth tube and anthers elongate to such an extent, that the latter brush against the edges of the stigmas and effect pollination.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Alps), 3 Lepidoptera, 2 humble-bees, a beetle, and a hover-fly. Ricca, bees, humble-bees, and Lepidoptera. Knuth (on garden plants, 29. 3. '94 and 21. 3. '96), the honey-bee, freq., actively po-cltg. Appel (Gossensass, April, 1898), several humble-bees; (Val di Ledro, 14 days later) extremely numerous bees flying from flower to flower (recorded in a letter to Knuth). Alfken (Bremen), the bee Podalirius acervorum *L.* ♂. Friese (Innsbruck), the bee Osmia bicolor *Schr.* ♀, po-cltg.; (Mecklenburg), the bee Podalirius acervorum *L.*, freq., po-cltg. Burkill (Yorkshire coast), the honey-bee, skg. and po-cltg.; by great efforts it seemed to reach the surface of the nectar ('Fertlsn. of Spring Fls.'). Heinsius (Holland), the bee Anthophora pilipes *F.* ♂, skg., and the humble-bee Bombus terrester *L.* ♀, po-cltg. (Bot. Jaarb. Dodonaea, Ghent, iv, 1892, pp. 117–18).

2671. C. reticulatus Steven (= C. variegatus *Hoppe et Horn.*).—

VISITORS.—Schletterer observed 6 bees at Pola.—

1. Eucera longicornis *L.*: 2. Halictus calceatus *Scop.*; 3. H. malachurus *K.*;

4. Podalirius acervorum *L.*; 5. P. retusus *L.*, var. meridionalis *Pér.*; 6. Xylocopa violacea *L.*

855. Gladiolus L.

Protandrous humble-bee flowers. Treviranus says that autogamy finally takes place by the bending back of the style.

2672. G. segetum Ker-Gawl. (Delpino, 'Ult. oss.,' p. 384; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 279, 282, 297; Loew, 'Blütenbiol. Floristik,' pp. 347–8; Grassmann, 'D. Septaldrüsen'; Urban, Ber. D. bot. Ges., Berlin, iii, 1885; K. F. Jordan, Inaug.-Diss., Halle, 1886.)—The purple-red flowers of this species possess, like those of the following one, a nectar-guide on the three lower perianth lobes in the form of white streaks edged with purple-red. The flower is 35–45 mm. long. Loew says that the perianth lobes split a little at the edges, and project more on the lower side than on the upper. The slightly bent flowers, with perianth tube about 10 mm. long and 3 mm. broad, are adapted by form and size for pollination by humble-bees, which find them conveniently large. In flowers in the first stage of anthesis, these visitors brush off the pollen from the anthers situated below the roof-shaped upper perianth lobes with their backs, and transfer it to flowers in which the stigmas have been brought into the line of access by elongation of the style; these are membranous, strongly papillose, and expanded downwards and forwards. Grassmann describes the accesses to the nectar secreted by the ovary as being right and left openings bounded by the filaments. Jordan says that the two lateral stamens twist round their pollen-covered sides towards these two openings. The anterior stamen is also at first turned outwards, but later on bends over backwards, so that the style is pressed against the posterior perianth lobe. Urban has given detailed descriptions of the latter torsion of the flowers, and the relation of their position to insect-visits.

Besides hermaphrodite flowers, Delpino observed purely female ones.

Visitors.—Loew (Berlin Botanic Garden) observed humble-bees, skg. normally and effecting pollinations; also smaller bees (Apis, Andrena sp.) as useless guests.

2673. G. triphyllos Sibth. et Sm.—

Visitors.—Loew (Berlin Botanic Gardens) observed the honey-bee, vainly skg.

2674. G. Gandavensis Van Houtte (= G. cardinalis *Curt.*, and G. psittacinus *Hook.*).—This hybrid is pollinated by long-tongued humble-bees, which remove pollen on their backs and transfer it to the stigma (Mágócsy-Dietz, 'A növénbiologia Köréböll').

2675. G. palustris Gaud. (Herm. Müller, 'Weit. Beob.,' I, p. 283; Knuth, 'Bloemenbiol. Bijdragen.')—This species possesses the same flower mechanism as G. segetum.

Visitors.—Borgstette (Tecklenburg) and Knuth (Gardens at Kiel) observed the humble-bee Bombus hortorum *L.* ☿, skg.

2676. G. communis L. (Herm. Müller, loc. cit.)—

Visitors.—Buddeberg (Nassau) observed 2 bees (Osmia rufa *L.* ♀, and O. adunca *Ltr.* ♂, skg.), and Schletterer (Tyrol), 2 bees (Bombus argillaceus *Scop.*, and Xylocopa violacea *L.*).

856. Iris Tourn.

Literature.—Kölreuter, 'Vorläufige Nachricht,' p. 21; Sprengel, 'Entd. Geh.,' pp. 69–78.

Herkogamous humble-bee or hover-fly flowers with large, arched, petaloid stylar branches.

2677. I. Pseudacorus L. (Sprengel, loc. cit.; Herm. Müller, 'Fertlsn.,' p. 543; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v. 1893, pp. 315–16; Ludwig, Biol. Centralbl., Erlangen, vi, 1887; Kirchner, 'Flora v. Stuttgart,' p. 80; Knuth, 'Bloemenbiol. Bijdragen.')—The large, yellow, odourless flowers of this species possess a nectar-guide on the sepals in the form of a dark-yellow patch bordered by a brown, zig-zag line; lines of the same colour also lead to the inside of the flower, where nectar is secreted by the base of the perianth, and stored in the tube between this and the style. The only means of access is found between the three large sepals, which serve as platforms, and the three petaloid stylar branches situated above them. Each of these three entrances is divided into two separate tubes by the filaments, which are fused with the sepals. Visitors seeking nectar creep forward on the platform under the stylar branch, bending back the upper side of the little stigmatic lappet in doing so, and dusting it with the pollen brought from another flower. In creeping further, the insect brushes against the anthers, which have dehisced downwards by two longitudinal slits, and dusts its back with fresh pollen. After having extracted nectar it creeps out backwards, but is unable to brush against the upper side of the stigmatic lobe again, as it has once more sprung upwards. Cross-pollination therefore takes place regularly, and occasionally also self-pollination as an exception; the latter, however, cannot occur automatically. A proboscis 7 mm. long is necessary to reach the nectar, and 15 mm. long to suck it all out.

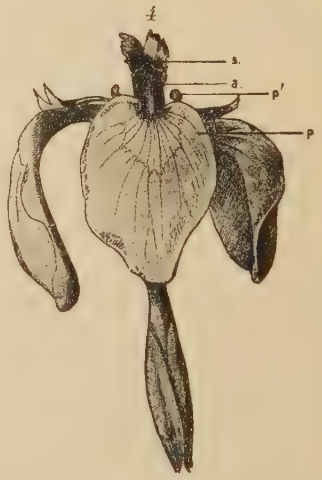


Fig. 391. *Iris Pseudacorus*, *L.* (1–3. after Herm. Müller, 4. from nature). (1) Transverse section through the perianth tube. (2) Do., through the perianth, at the point where the sepals and petals become free. (3) Transverse section somewhat higher than (2), showing the boundaries of the nectar-passages. *a*, style; *a' a' a'*, petaloid stylar branches; *b*, nectar-passages; *c*, adherent part of filament; *d d d*, sepals; *d' d' d'*, petals; *e e e*, ridges on sepals. (4) Flower from the side (× 2): one of the three petaloid stylar branches is lifted up to show an anther (*a*) and a stigma (*s*); *p*, sepal with nectar-guide; *p'*, petal.

The flowers occur in three oecological forms:—

(a) *bombophila* Knuth. The stylar branches are situated 6–10 mm. above the corresponding sepals. This distance corresponds to the height of a creeping humble-

bee, while smaller insects, especially certain frequently occurring hover-flies (Rhingia rostrata *L.*), neither bend back the stigmatic lappet nor touch the anthers. Such a visitor, as Hermann Müller describes, and I have often observed, walks on one of the sepals to the nectar-entrances, inserts its proboscis (11 mm. long), first into one, then into the other, and after drinking, goes some steps backwards, to eat also. As soon as the insect comes beneath the anther, it raises its head, stretches its long proboscis up to it, and devours pollen. Its visits to flowers of this form are thus not only useless, but actually injurious.

(b) *syrphophila* Knuth. The stylar branches are situated close to the corresponding sepals. Small entrances to the spaces thus enclosed are left below the stigmatic lappets, owing to the arched form of the stylar branches. These are large enough to admit a hover-fly of medium size, and especially the Rhingia mentioned above, while a humble-bee cannot force its way in. In form (b) a hover-fly behaves exactly like a humble-bee in form (a), creeping under the stylar branch, first brushing against the stigmatic lappet and then the anthers with its back, drinking from both nectar-passages, backing out of the flower without devouring pollen, and then flying to another. Humble-bees are equally injurious visitors for form (b) as Rhingia for form (a). Hermann Müller observed a large parasitic humble-bee (Psithyrus vestalis *Fourcr.* ♀, 25 mm. long and 10 mm. broad) going round the flower repeatedly, inserting its proboscis and sucking laterally above the base of the free part of a sepal into one of the two nectar-passages, so that neither anthers nor stigmas were touched.

(c) *intermedia* Knuth. The distance between the sepals and the stylar branches is intermediate between those given for (*a*) and (*b*). This form is rare.

According to Hermann Müller's observations, humble-bees do not creep out of form (a) backwards, as Sprengel has described, and as I have frequently seen, but after sucking all the nectar from one of the three double tubes in each flower, they shorten the way to another considerably by gripping one of the two adjacent sepals laterally and climbing on to it. They then force their way under the stylar branch, suck nectar, and proceed in the same way with the third nectar receptacle. They next fly to another flower, to behave in the same manner; thus cross-pollination only is effected in doing this. Hermann Müller only saw humble-bees back out of flowers of form (c) to settle on another sepal of the same or a different flower. This intermediate form combines the disadvantages of the other two, for it is neither protected from theft of pollen by Rhingia nor from theft of nectar by Bombus. This accounts for its comparative rarity. Warnstorf describes the pollen-grains as yellow in colour, globular when examined in water, with a network of tubercles, very large, on an average 125 μ in diameter.

Visitors.—Herm. Müller (H. M.) and Knuth (Kn.) observed the following.—

A. Hymenoptera. *Apidae*: 1. Apis mellifica *L.* ☿ (Kn., H. M.), vainly looking for nectar, or at most reaching the top of it; then backing out sideways; 2. Bombus agrorum *F.* ♀ and ☿ (Kn., H. M.), skg., observed by Kn. more frequently than the following; 3. B. hortorum *L.* ♀ and ☿ (Kn., H. M.), do.; 4. B. rajellus *K.* ♀ (H. M.), do.; 5. Osmia rufa *L.* ♀ (H. M.), do., but too small to effect pollination; 6. Psithyrus vestalis *Fourcr.* ♀, stealing nectar. **B. Diptera.** *Syrphidae*: 7. Rhingia rostrata *L.* (Kn., H. M.), skg. and po-dvg.

2678. I. xiphioides *Ehrh.* (=I. pyrenaica *Bub.*). (MacLeod, 'Pyreneënbl.,' pp. 306–9.)—The large flowers of this species belong to class **Hb**. They are blue in colour, with yellow stripes on the sepals as nectar-guides. Their mechanism agrees with that of the preceding species, but a proboscis only 7 mm. long can suck all the nectar. No oecological forms, however, can be properly distinguished as in I. Pseudacorus, as numerous transition-forms occur between flowers with a larger or smaller distance between stylar branches and the sepals.

Visitors.—MacLeod (Pyrenees) observed the humble-bee Bombus hortorum *L.* ☿, which backed out of the flowers when leaving them. Loew (Berlin Botanic Garden) saw the honey-bee, vainly skg.

2679. I. pumila L. (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896, pp. 55–6.)—In flowers of this species the anthers are sometimes situated below the stigmatic lappets, and sometimes project beyond them. In the former case the visitors on creeping in must first touch the papillose inner surface of such a lappet, while in the other flowers they only come into contact with the outwardly dehiscing anther and dust their upper-side with pollen. Anthesis lasts only one day. The large pollen-grains are very irregular, white in colour, with prominent tubercles often united into ridges, up to 100 μ in diameter.

2680. I. graminea L. (Knuth, Bot. Centralbl., Cassel, lxxv, 1898.)—In this species the distance between the stigmatic lappets and the large sepals marked with nectar-guides is so small that the honey-bee can only force its way through with difficulty to get to the nectar. It brushes the stigmatic lappet in doing so, and dusts the downwardly bent upper-side of this with foreign pollen, gathering a fresh supply on going further into the flower by brushing against the dehisced anther. The nectar-tube is 5–5½ mm. long, and therefore corresponds exactly to the length of the honey-bee's proboscis, which is about 5–6 mm.

I saw the beautiful, violet-blue flowers, which possess an odour of nectar (resembling that of plums, according to the Plant Catalogue), on June 18, 1898, in the garden of the Oberrealschule in Kiel visited by numerous individuals of Apis mellifica *L.* ☿, which effect pollination as has been described above. They usually crept out of the flower sideways after sucking nectar, but in many cases, where the lateral entrance was narrow, also backwards out of the entrance; this, however, apparently caused them considerable trouble.

2681. I. sibirica L. (Loew, 'Blütenbiol. Floristik,' pp. 346–7; Dodel-Port, 'Iris sibirica.')—The fragrant blue flowers of this species possess arcuate sepals, 46–51 mm. long, with a beautiful marking as nectar-guide. They are blue, with darker forked veins, and yellow at their greatly contracted base, with violet cross-veins, some longitudinal veins of a medium blue, and blue streaks on a white ground; further up there is a larger white patch with blue veinings. There is a white border about 3 mm. high, with bluish markings, on both sides of the base of the sepals; it rests on each side against a small, tooth-like projection of the narrowed base of the petals. These are erect, and blue in colour, delicately veined. The three petaloid stylar branches are situated fairly close to the sepals and project 6–9 mm. beyond the stamens below them.

Loew and Dodel-Port describe the flowers as protandrous. The anthers are

dehisced when the flowers open, while the upper surface of the triangular stigmatic lappets are still pressed against the stylar branches covering them. Later on, each stigmatic lappet bends downwards, so that the papillose upper-side is brushed against and dusted by a humble-bee creeping in; this cannot happen in the first stage, only the pollen-covered anther being then brushed against. Cross-pollination is thus ensured.

Visitors.—Loew (Bredower Forest near Nauen) observed 2 humble-bees—Bombus variabilis *Schmiedekn.*, and Psithyrus campestris *Pz.* (op. cit., p. 391): (Berlin Botanic Garden), the humble-bee Bombus hortorum *L.* ♀, skg.

2682. I. germanica L.—

Visitors.—Loew (Berlin Botanic Garden) observed the humble-bee Bombus hortorum *L.* ♀, skg.

857. Aristea Ait.

2683. A. pusilla Ker-Gawl. (Francke, 'Inaug.-Diss.,' Halle, 1883.)—Francke describes flowers of this species as homogamous, but autogamy is excluded by the position of stigma and anthers. Pollination is effected by means of wind or insects.

858. Sisyrinchium L.

Hansgirg describes all the species of this genus examined by him as bearing flowers which last only for a single day (Bot. Centralbl., Cassel, xliii, 1890).

2684. S. anceps Lam. (Loew, 'Blütenbiol. Floristik,' p. 346; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 190, 391.)—Flowers of this North American species last for only one day; Kerner states that they open between 10–11 a.m., closing again about 4–5 p.m. The perianth lobes are blue, with green-yellow spots at the base, and are flat when expanded. They unite to form a tube about one mm. long, which, according to Kerner, secretes nectar internally; Loew states, however, that this does not exude in free droplets. The filament-tube surrounding the style bears the outwardly directed anthers, which dehisce while still in the bud and are at first exceeded in length by the stylar branches. Autogamy is possible towards the end of anthesis, the perianth then elongating so that the stigmas come into contact with the pollen adhering to the inner side of the perianth. Kerner states that in unfavourable weather automatic self-pollination takes place pseudo-cleistogamously, as the flowers remain closed.

Visitors.—Loew (Berlin Botanic Garden) observed small bees (Halictus minutissimus *K.* ♀, skg.).

859. Tigridia Juss.

2685. T. Pavonia Ker-Gawl.—Duchartre says that the flowers of this species usually begin to open between 5–6 a.m. and are full-blown at 10 a.m. Between 2 and 3 p.m. they begin to fade, and are completely withered at 5 p.m.

860. Hermodactylus Tourn.

2686. H. tuberosus Mill. (Arcangeli, Boll. Soc. bot. ital., Firenze, 1895, pp. 182–4.)—Arcangeli describes the flowers of this species as odourless; he says

that they bloom in February, and are marked with dark spots which in the distance look like larger bees.

Visitors.—The bee Xylocopa violacea *L.* is attracted by the mimicry just described, and effects cross-pollination.

CXI. ORDER *AMARYLLIDEAE* R. BR.

Literature.—Knuth, 'Grundriss d. Blütenbiol.,' p. 99; Pax, 'Amaryllidaceae,' in Engler u. Prantl, 'D. nat. Pflanzenfam.,' II, 5, pp. 100–117.

The two whorls of the superior petaloid perianth serve to render the flowers conspicuous. In Narcissus and Tazetta this is further increased by a corona, which at the same time serves to conceal the nectar more deeply.

861. Narcissus L.

Homogamous to feebly protogynous humble-bee or lepidopterid flowers, secreting and concealing nectar at the base of the perianth tube. Sometimes dimorphism to polymorphism.

Loew ('Blütenbiol. Beiträge,' II, p. 84) distinguishes the following groups according to pollination mechanisms.

(1) Humble-bee flowers: corona large, bell-shaped; perianth expanded at the end like a funnel, only slightly or not at all narrowed by the anthers. N. odorus *L.*, N. Pseudo-Narcissus *L.*

(2) Intermediate stage between humble-bee and lepidopterid flowers: corona cup-shaped, tolerably deep; perianth tube narrow, moderately long; upper anthers projecting from, and lower ones enclosed in it. N. triandrus *L.*

(3) Lepidopterid flowers: corona shaped like a flat dish, with crenulate margin; perianth tube long, very much narrowed by the anthers. N. poëticus *L.*, N. biflorus *Curt.*

(4) Humble-bee and lepidopterid flowers: corona cup-shaped; perianth tube moderately long, slightly expanded at the top; flowers small; perianth lobes shorter than the tube. N. Tazetta *L.*, N. polyanthos *Loisel.*, N. primulinus *Haw.*

(5) Lepidopterid flowers: corona shaped like a shallow dish; perianth tube very long and thin, and narrowed still more at the entrance by the anthers. N. Jonquilla *L.*

2687. N. poëticus L. (Kirchner, 'Flora v. Stuttgart,' p. 73; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 311.)—The white, pendulous flowers of this species are adapted for pollination by Lepidoptera. They possess a strong odour of pinks and are rich in nectar, with a greenish-yellow, dish-shaped corona, possessing a crenulate, vermilion-red margin. Kirchner describes them as homogamous, Kerner as feebly protogynous. The perianth tube is about 30 mm. long. The six anthers are situated in the entrance in two whorls, one close under the other, the upper three being smaller than the lower three. They all dehisce introrsely, and must be touched by visitors as well as the stigma, for they fill the flower entrance almost completely. The stigma is situated in the entrance to the perianth tube between the three upper anthers, so that automatic self-pollination must take place if insect-visits fail. Kerner

says that the anthers, originally about 11 mm. long, contract after dehiscence to a length of about 4 mm.

2688. N. biflorus Curt. (Loew, 'Blütenbiol. Beiträge,' II, p. 82.)—The flower mechanism of this species agrees with that of N. poëticus, but the perianth tube is only 26 mm. long, 5 mm. wide at the top, and 4 mm. at the bottom. The species seems, therefore, to be adapted for pollination by nocturnal Lepidoptera.

2689. N. Pseudo-Narcissus L. (Knuth, 'Bloemenbiol. Bijdragen'; Burkill, 'Fertlsn. of Spring Fls.')—The flowers of this species are adapted for pollination by humble-bees; they are pale yellow in colour, with a golden-yellow, somewhat funnel-shaped corona. Burkill says that the perianth is 40–50 mm. in diameter, its tube 45 mm. long, and 15 mm. broad at the opening. The stamens and the stigma projecting 4–5 mm. beyond them are surrounded by the perianth. The anthers dehisce introrsely immediately after the flower opens, and shed part of their pollen upon the style. Larger insects on entering the flower first touch the stigma, and later on the pollen-covered anthers and the style. As the flowers are homogamous, one insect visitor is enough to pollinate a single flower. The entrances to the three nectaries at the base of the flower are situated between the filaments; they are 1–1½ mm. wide, and 6 mm. distant from the nectar, so that a proboscis of that length can reach it. Warnstorf describes the pollen-grains as yellow in colour, irregularly ellipsoidal, tuberculate, up to 63 μ long and 30 μ broad.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (gardens at Kiel), the long-tongued bee Anthophora pilipes *F.* ♀, which forced its head and thorax into the flowers, and was able to secure the honey with its proboscis (19–21 mm. long), and effected crossing. Also the beetle Meligethes deep within the flower, either as an unbidden guest, or else very occasionally effecting self-pollination. Höppner (Bremen), the bee Osmia rufa *L.*, skg. Schenck (Nassau), the bee Osmia rufa *L.* ♂. von Fricken (Westphalia and East Prussia), the Nitidulid beetle Epurea aestiva *L.* Delpino ('Ult. oss.'), a long-tongued bee as pollinator. Burkill (Yorkshire coast).—**A. Acarina.** 1. An undetermined sp. creeping about the flowers. **B. Diptera.** (*a*) *Muscidae*: 2. Phorbia muscaria *Mg.*, vainly seeking nectar in all parts of the flowers, and apparently sometimes effecting self-pollination; 3. One other Muscid, searching for nectar. (*b*) *Syrphidae*: 4. Eristalis pertinax *Scop.*, searching for nectar. **C. Hymenoptera.** *Apidae*: 5. Andrena clarkella *K.* ♀, vainly searching for nectar. **D. Thysanoptera.** 6. Thrips sp.

2690. N. calathinus L. (=N. reflexus *Loisel.*; and N. odorus *L.*, according to the *Index Kewensis*). (Crié, 'Sur le polymorph. fl. du Narcisse.')—Plants of this species occur in three forms in the Glenan islands; one long-styled, one short-styled, and a third with three normal and three reduced stamens.

2691. N. triandrus L. (Wolley C. Dod, 'Polymorphism of organs in Narcissus triandrus'; Loew, 'Blütenbiol. Beiträge,' II, pp. 81–2.)—Loew describes the flowers of this Spanish species as protandrous, with a mechanism adapted for both long-tongued bees and Lepidoptera. Dod also describes the species as polymorphous, and distinguishes three chief varieties with regard to the relative length of stamens and styles.

2692. N. odorus L. (Loew, 'Blütenbiol. Floristik,' pp. 348–9.)—The flowers of this species are adapted for pollination by humble-bees. The perianth tube of

the sulphur-yellow flower is 19 mm. long, and funnel-shaped above. The bell-shaped corona, provided with six blunt lobes, is 12 mm. long and 17 mm. broad. As the stigma is situated above the anthers, it is brushed against by suitable visitors before the latter. Both organs project far into the corona, and thus do not bar the entrance to the perianth tube, which conceals the nectar at its base.

Visitors.—Loew (Berlin Botanic Garden) observed the long-tongued bee Anthophora pilipes *F.*

2693. N. Jonquilla L. (Loew, 'Blütenbiol. Beiträge,' II, pp. 83–4.)—The perianth tube in this species is very long (30 mm.) and narrow (2 mm.). The three upper anthers project about 2 mm. beyond the stigma, leaving free only three very narrow entrances into the tube; the tips of the lower ones are about 4 mm. distant from the entrance. The protogynous flowers are undoubtedly adapted for pollination by Lepidoptera.

2694. N. polyanthus Loisel. (=N. Tazetta *L.*, according to the *Index Kewensis*).—

Visitors.—Loew (Berlin Botanic Garden) observed the bee Anthophora pilipes *F.* ♀.

2695. N. primulinus Haw. (Loew, loc. cit.)—The anthers of the three upper stamens in this species leave only three narrow entrances to the flower, and project about one mm. beyond the stigma, which is somewhat longer than the lower anthers, situated rather deeply in the perianth tube.

2696. N. juncifolius Req. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 378.) —Kerner describes the flowers of this species as being at first horizontal, and becoming erect later on, so that autogamy can take place by fall of pollen.

2697. N. Tazetta L. (Delpino, 'Altri appar. dicog. recent. oss.,' p. 59; Arcangeli, 'Compend. d. Fl. ital.,' p. 677; Loew, 'Blütenbiol. Beiträge,' II, p. 83; Knuth, 'Bloemenbiol. Bijdragen.')—The fragrant flowers of this species are yellow or white in colour, with a yellow or orange corona. The three upper anthers project rather more than the three lower ones. They close up the throat except for six narrow entrances. Loew says that the stigma is situated rather deeply below the anthers. Arcangeli describes the style as only slightly shorter than the upper stamens. Loew found the flowers protogynous.

Visitors.—Delpino believes these to be chiefly nocturnal or crepuscular Lepidoptera, but he observed the bee Anthophora pilipes *F.* I also saw the same bee on garden plants in Kiel.

862. Crinum L.

The white, fragrant protandrous flowers of species belonging to this genus are 15 cm. long, with strongly exserted stamens and stigma. Delpino saw them to be visited by Lepidoptera at Florence. He supposes that in the native country of these plants nectar-sucking birds also take part in their pollination.

863. Pancratium Dill.

2698. P. maritimum L. (Delpino, 'Altri appar. dicog. recent. oss.,' p. 56.)—Delpino states that flowers of this species conceal nectar so deeply that only

long-tongued crepuscular and nocturnal Lepidoptera and the bee Anthophora pilipes occur as visitors (at Florence).

864. Leucojum L.

White flowers, marked with green spots below the tip of the perianth leaves, apparently secreting no free nectar, but possessing a ridge of juicy tissue at the base of the style.

2699. L. vernum L. (Sprengel, 'Entd. Geh.,' pp. 181–2; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. I, II, pp. 170, 190, 201, 274; Knuth, 'Bloemenbiol. Bijdragen'; Bot. Centralbl., Cassel, lxxiv, 1898, pp. 161–5.)—The inner parts of flowers of this species are protected from rain by the pendulous position and the roof-like arrangement of the perianth whorls. Sprengel considered the middle part of the style the nectar-secreting organ. He says: 'I have found nectar in this part in all flowers except the very old ones. Though this use for the style is very unusual, its form is equally so, and only to be explained by this theory, being so thick, as is also the green nectar-guide with which it is decorated at the tip.' Kerner describes the fleshy base of the flower as the nourishment offered to visitors. As all the petals are longitudinally streaked, and the colourless streaks converge to the base of the flower, this supposition, though I cannot confirm it from direct observation, becomes still more probable. Since the petals are also a little swollen at their bases, and are situated on the margin of the swelling into which the stamens are also inserted, it is not improbable that the whole tissue of the flower-base contains sap and is bored by visitors. I was never able to recognize secretion of free nectar. Regarding the probable position of the nectary *cf.* L. aestivum. The younger flowers have a rather strong odour of violets, the older an unpleasant smell distantly resembling that of bitter almonds.

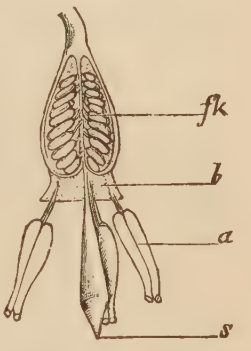


FIG. 392. *Leucojum vernum*, *L.* (from nature). Partly dissected flower, after removal of the perianth and three stamens (× 2). *a*, anthers; *b*, spongy sugar-containing base of the flower; *fk*, ovary with ovules; *s*, stigma.

The pendulous flowers are homogamous. The anther-lobes of the six stamens dehisce downwards, and when lightly touched allow a small quantity of yellow pollen to fall out, so that insect visitors must be dusted with it as soon as they enter the flower. As the stigma projects slightly beyond the anthers it is touched first by visitors, and is thus cross-pollinated. In widely opened flowers the anthers are at first so far from the stigma that autogamy cannot take place. This, however, occurs when the flowers close in the evening, the anthers and the usually pollen-covered inner sides of the petals then coming into contact with the stigma.

VISITORS.—Knuth observed numerous skg. and po-cltg. honey-bees, and also (21.3.'96) the butterfly Vanessa urticae *L.*, skg. MacLeod (Flanders) also noticed the honey-bee (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 315).

2700. L. aestivum L. (Loew, 'Blütenbiol. Floristik,' p. 349; Knuth, 'Bloemenbiol. Bijdragen,' Bot. Centralbl., Cassel, lxxv, 1898.)—The flower mechanism of this species is the same as that of the preceding one, but the style is considerably

thinner and rather longer, so that the tip of the stigma projects 3 mm. beyond the anthers. It follows that cross-pollination by insect-visits is even more effectually ensured than in L. vernum. Should these fail, automatic self-pollination can take place when the flower closes, the pollen left clinging to the perianth leaves being then pressed against the stigma.

I looked for the nectary in the same way as in L. vernum, treating the whole of the flower, however, instead of the individual parts, with Fehling's solution, and with the Hoppe-Seyler sugar reagent O-nitro-phenyl-propionic acid, which precipitates indigo when heated with reducing substances (Zs. physiol. Chemie, vii, p. 83). By treating a number of excised green parts of the plant I had found that each freshly cut surface effects reduction of the reagent and deposits upon it either copper oxide or indigo. When I treated the whole flowers with the reagent I avoided freshly cut surfaces, the exuding juice of which had effected reduction[1]. I then found that the flowers of L. aestivum showed a deposit of copper oxide and of indigo respectively (when treated with Fehling's solution and the Hoppe-Seyler reagent) only in the middle of the perianth leaves below the green patches on their tips. This was also the case on a smaller scale with the whole style below

[1] I have also examined in this way a number of other flowers in which the position of the nectary is doubtful. Entire flowers were soaked in the reagent for twenty-four hours, then heated to the boiling-point, and finally well washed with cold water. The following results were obtained.—(1) Tulipa sylvestris *L.*: the hairs at the bases of the filaments showed a marked deposit of pigment, especially on their inner sides, and the mature stigmatic papillae were covered with indigo. (2) Tulipa Gesneriana *L.*: the bases of the perianth leaves were permeated by indigo for a distance of about 1½ cm.; the tips of the filaments and the stigmatic papillae also turned blue. (3) Orchis latifolia *L.*: in flowers treated with the reagents the spurs only became filled with indigo or cuprous oxide respectively: the presence of sugar in the tissues was thus demonstrated. (4) Maianthemum bifolium *Schmidt*: this only sometimes presented a deep blue colouration of the base of the flower, ovary, and stigma, from which it must be concluded that the secretion of nectar of flowers from the same station is variable. (5) Polygonatum officinale *All.*: the tissue in the upper part of the corolla, beneath the green terminal nectar-guides, became deep blue or red from precipitated indigo or cuprous oxide, respectively, indicating the position of the nectar: there was no precipitation in the wall of the ovary. (6) Convallaria majalis *L.*: the base of the flower and the perianth showed a rich deposit of colouring matter, proving the presence of sugar-containing tissue. (7) Nymphaea alba *L.*: the stigmas of flowers treated with the reagents showed a deposition of colouring matter. (8) Cytisus Laburnum *L.*: the swelling surrounding the insertion of the vexillum in front became dark blue from precipitation of indigo after treatment with nitro-phenyl-propionic acid, so that juicy tissue is here present. (9) Vitis vimifera *L.*: all the parts of the flower (except the anther-lobes) were strongly charged with colouring matter after treatment with the above-named acid: with Fehling's solution the nectaries became dark and the stigma pale brick-red, while the remaining parts remained colourless. The conclusion may probably be drawn that the nectaries are the chief seat of secretion. (10) Symphoricarpos racemosa *Michx.*: after treatment with nitro-phenyl-propionic acid all the tissue of the base of the flower, including the hairs, and also the tissue of the ovary surrounding the ovules showed strong precipitation of indigo. This indicates the seat of nectar to be obtained by boring. (11) Solanum Dulcamara *L.*: in flowers treated with the reagents there was a strong deposit of colouring matter in the tissue of the flower-base surrounding the ovary, so that the presence of sap in that region must be inferred. (12) Glaux maritima *L.*: flowers treated with nitro-phenyl-propionic acid took on a violet tint, which was strongest in the central part of the perianth leaves, where these adjoin the ovary. The position of sugar-containing tissue is thus indicated. A detailed account of these investigations and the conclusions drawn from them will be found in 'Über den Nachweis von Nektarien auf chemischem Wege' (Bot. Centralbl., Cassel, lxxvi, 1898).

its thickened greenish tip. It may be inferred that secretion of nectar takes place in the parts mentioned.

It thus appears necessary to examine once more the whole flowers of Leucojum vernum *L.*, and also of Galanthus nivalis *L.*, sections of which I had treated with the reagents mentioned.

Visitors.—In gardens at Kiel Knuth observed the honey-bee as a visitor and pollinator of L. aestivum, but could not discover the manner in which it worked. In the Berlin Botanic Garden Loew noticed the bee Podalirius acervorum *L.* ♀, po-cltg.

865. Galanthus L.

As Leucojum. Nectar-guide only on the tips of the petals.

2701. G. nivalis L. (Sprengel, 'Entd. Geh.,' pp. 177–80; Herm. Müller, 'Fertilisation,' p. 589; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 176; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 315; Stadler, 'Beiträge'; Delpino, Bot. Centralbl., Cassel, xxxix, 1889, p. 124; Kirchner, 'Flora v. Stuttgart,' p. 73; Knuth, 'Bloemenbiol. Bijdragen,' Bot. Centralbl., Cassel, lxxiv, 1898.)—The white flowers of this species are homogamous. Each of the short petals possesses a yellow-green, lunate, transverse band outside, and a number of green, longitudinal lines inside as nectar-guides. Hermann Müller and Kerner state that the nectar is secreted in the grooves: I have examined transverse sections of the latter under a microscope, but could find no secretory cells there. There is a layer of strongly projecting cells externally, bearing colourless protoplasm and causing the white colour of the outside; beneath this is found assimilation-tissue. The upper and lower sides of the petal are connected by parenchymous mesophyll with small vascular bundles. On the lower side there is a row of thinner, air-containing cells, through which the assimilation-tissue is visible. In the indentations there is, however, no chlorophyll to be found in the posterior cells, which causes the alternate green and white streaking internally. Stadler considers the disk surrounding the style as a nectary without free secretion. Delpino thinks that the cordate green spots and the 6–7 green, longitudinal lines on the inside of the petals are nectaries. There is also a small quantity of nectar produced by a circlet of very small pits at the base of the style. Sprengel supposes the petals to be both nectar-receptacles and glands; 'They do not, however, secrete nectar on the whole of their inner surface, but only in the middle as far as they are green.'

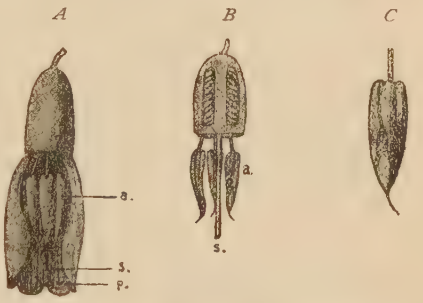


Fig. 393. *Galanthus nivalis*, *L.* (from nature). *A.* Lateral view of a flower, after removal of half the perianth. *B.* Do., with ovary in longitudinal section, after removal of the perianth and three stamens. *C.* A stamen, further enlarged, with dehisced anther. *a*, anthers; *p*, petals with nectar-guides; *s*, stigma.

In unopened snowdrops brought to my laboratory at 8 a.m. I could find no free nectar. As the flowers opened after some time in consequence of the warmth of

the room, I observed a distinct secretion of nectar in the depressions on the inner sides of the petals, and could also perceive it by taste.

The inner parts of the flower are protected from rain by its pendulous position. The anthers form a downwardly directed sprinkling-cone surrounding the style. They dehisce by means of a down- and inwardly directed, lancet-shaped opening. Each ends in a brush-like elongation, which is struck against by insect visitors, so that some pollen falls off upon them. As the stigma projects a little beyond the anthers, it is touched first, so that insect-visits effect cross-pollination. Warnstorf describes the pollen-grains as dark golden-yellow in colour, ellipsoidal to nearly bean-shaped, on an average 37 μ long and 25 μ broad, without visible germinating processes.

Visitors.—Sprengel observed honey-bees. In sunny weather they may be seen in swarms searching for the pollen and nectar. In such weather the sepals, which usually closely surround the petals, diverge so that the green nectar-guides may be seen. Hermann Müller describes in detail how the honey-bee uses one of the sepals as a platform, and turns thence to the entrance of the flower. When collecting pollen it inserts its head and fore- and middle-legs into the flower, and clings firmly with its hind-legs to the outer side of a petal. In this position it brushes against the anthers with the tarsal brushes of its fore- and middle-legs, and deposits the pollen thus obtained in the collecting-baskets of the hind-legs. When sucking it also generally holds fast to the perianth leaves from outside with its fore- and middle-legs.

866. Sternbergia Waldst. et Kit.

2702. S. lutea Ker-Gawl. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 373.)—Kerner states that the flowers of this species are protogynous, so that at first insect-visits are necessary for pollination. After the anthers have dehisced, insects probing for the nectar found at the base of the flower first brush against the stigma and dust it with foreign pollen; on penetrating further they receive fresh pollen from the anthers. The flowers close in the evening, and pollen is then deposited on the inner side of the perianth leaves. This is transferred to the stigma on the following evening, for the perianth lobes elongate greatly during the day, so that their pollen-covered parts are then on a level with the stigma, enabling autogamy to take place.

867. Agave L.

2703. A. lurida Ait. (=A. Jacquiniana *Schult.*). (Stadler, 'Beiträge.')—Stadler describes flowers of this species as markedly protandrous, so that autogamy is excluded.

Visitors.—These are Muscids.

CXII. ORDER *TACCACEAE* BENTH. ET HOOK.

868. Tacca Forst.

2704. T. cristata Knuth (=Ataccia cristata *Jack*). (Delpino, 'Ult. oss.,' pp. 13–16; Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870, p. 589.)—In this species

the stigma closes up the flower-kettle except for some small openings, into which, according to Delpino's supposition, small midges creep and dust themselves with pollen. If they then fly to another flower, they touch the stigma first, thus effecting cross-pollination.

869. Aspidistra Ker-Gawl.

2705. A. elatior Blume. (Buchenau, Bot. Ztg., Leipzig, xxv, 1867, pp. 220–2.) —This species possesses a similar flower mechanism to that of Tacca cristata. It was not explained by Buchenau.

CXIII. ORDER *DIOSCOREACEAE* R. BR.

870. Tamus L.

2706. T. communis L.—This species bears greenish flowers.

Visitors.—Plateau observed 2 bees (Apis and Andrena sp.), a Muscid (Calliphora vomitoria *L.*), and a Scarabaeid beetle (Trichius abdominalis *Mén.*).

CXIV. ORDER *LILIACEAE* DC.

Literature.—Herm. Müller, 'Fertlsn.,' pp. 548–59; Knuth, 'Grundriss d. Blütenbiol.,' pp. 99–100.

In species of this order the two whorls of the inferior petaloid perianth serve, often together with the stamens, to make the flowers conspicuous. When small they are aggregated into racemes, capitula, umbels, or spikes.

The individual species partly bear pollen-flowers, and partly those secreting nectar either at the base of the carpels or the perianth leaves. The pollen-flowers attract either pollen-collecting or pollen-devouring insects (species of Tulipa, Convallaria, Narthecium) or are perhaps deceptive flowers attracting stupid, carrion-loving flies (Paris). Flowers secreting nectar by the ovary or provided with juicy tissue in that region may be arranged in the following classes:—

E: Tofieldia, Anthericum;
EC: Ornithogalum;
C: Allium, Hyacinthus (in part);
Hb: Hyacinthus (in part), Muscari, Polygonatum (in part);
Hb: Polygonatum (in part);
L: Paradisea.

Flowers secreting nectar at the base of the perianth leaves may be similarly classified:—

E: Veratrum, species of Gagea, Lloydia;
EC: species of Gagea;
C: Fritillaria;
L: Lilium.

871. Tulipa L.

Partly homogamous pollen-flowers, partly flowers with concealed nectar.

2707. T. sylvestris L. (Kirchner, 'Flora v. Stuttgart,' p. 56; Kerner, 'Nat.

Hist. Pl.,' Eng. Ed. 1, II, pp. 120, 203, 240, 379; Loew, 'Blütenbiol. Floristik,' pp. 353–4; Mattei, 'I tulipani di Bologna.')—The fragrant yellow flowers of this species are homogamous. Kerner says that they secrete nectar at the base of the stamens, the outer side of each filament being provided with a pit, by which nectar is secreted and stored. This pit is completely covered by a tuft of hairs, so that an insect probing for nectar must raise the stamen. Kirchner also considers this spot a nectary, and Mattei states that free nectar is found there. Loew has examined the North German plants of this species, and observed no secretion of nectar at the base of the stamens[1]. He found that in bright sunshine the flowers expand to a star about 8 cm. in diameter, and that the stamens also diverge almost at right angles from the ovary. The filaments are provided with a tuft of hairs not only on the hollowed lower side of their base, but also on their upper side; but no free nectar could be discovered here. The yellow stigma, however, which is the highest part of the flower, often secretes minute drops of liquid, and small bee visitors (species of Andrena and Halictus) flew first to this, and afterwards to the anthers, which are situated lower down and are less conspicuous, on account of their darker colouring, to collect pollen. They thus effected cross-pollination regularly. Loew never observed such visitors searching for nectar at the base of the stamens, but they sometimes probed at the base of the ovary. Besides these bees there were sometimes some flies also, which licked the small drops off the stigma.

Kerner says that should insect visits fail, autogamy may take place, the flower stalk ultimately bending down so far that the stigma is brought into the line of fall of the pollen.

Visitors.—Loew ('Blütenbiol. Beiträge,' II, pp. 72–3) observed small po-cltg. bees (Andrena fulva *Schr.*, A. extricata *Sm.*, and Halictus sp.), and po-dvg. flies (Eristalis numorum *L.*, Syrphus ribesii *L.*, Myopa testacea *L.*, and Anthomyia sp.).

2708. T. Oculus-solis St. Amans. (Kirchner, 'Beiträge,' p. 5; Knuth, 'Bloemenbiol. Bijdragen.')—Kirchner has described the flower mechanism of this South German species in plants run wild from the Hohenheim Exotic Garden. They bear homogamous pollen-flowers, devoid of nectar, and possessing a feeble fragrance resembling that of Taraxacum. They are erect, with scarlet perianth leaves, glossy at the base and marked with a large, black, yellow-edged spot; the three petals also possess a yellowish median streak. The filaments are glabrous, yellow at the base, and blackish at the tip; the anthers contain black pollen. The stigma is usually at the same level as the tips of the anthers, but the latter not infrequently project about 5 mm. beyond it. Automatic self-pollination is excluded by the position of the flowers, in addition to the fact that there is a distance of 5–8 mm. between stigma and anthers.

Visitors.—Knuth (gardens in Kiel) observed the honey-bee, po-cltg.

2709. T. Gesneriana L. (Van Tieghem, 'Recherches'; Knuth, op. cit.)—The feebly fragrant flowers of this species, rendered very conspicuous by the vivid colouring of the perianth leaves, expand in sunshine like a star. They are homogamous pollen-flowers, though Tieghem states that nectaries are indicated in the

[1] *Cf.* the foot-note to Leucojum aestivum *L.*

ovary, but do not open to the exterior[1]. The flower mechanism agrees essentially with that of the preceding species, but automatic self-pollination becomes possible when the flowers close in dull weather.

Visitors.—Knuth (Kiel Botanic Garden) observed the honey-bee (26. 4.'69), po-cltg., but not touching the stigma.

2710. T. Didieri Jord.—

Visitors.—Loew (Berlin Botanic Garden) observed a Scarabaeid beetle (Octonia mirata), po-dvg. in the base of the flowers, and a bee (Halictus cylindricus *F.* ♀), lying in the base of the flower, and thickly covered with pollen.

872. Gagea Salisb.

Flowers odourless, green externally and yellow internally, being thus only conspicuous when open. Nectar exposed to half-concealed, and secreted at the base of the perianth leaves in the angle between them and the superposed stamens. Schulz states that the stamens or the style are sometimes absent in almost all species. Usually protogyny.

2711. G. fascicularis Salisb. (= G. lutea *Ker-Gawl.*, and G. sylvatica *Loud.*). (Herm. Müller, 'Weit. Beob.,' I, p. 274; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 93, 391; Knuth, 'Bloemenbiol. Bijdragen.')—Hermann Müller says that the open flowers of this species are feebly protogynous. When they open, the stigmas are provided with long papillae, but the anthers dehisce soon afterwards, both they and the stigmas remaining functional, throughout anthesis. Kerner describes the anthers as being only about a third of their original length after dehiscence. Cross-pollination is ensured by insect-visits in the first stage of anthesis; and in a later one, self-pollination may be effected with equal facility; this may then also take place automatically. Kerner states that autogamy occurs pseudo-cleistogamously in flowers remaining closed in bad weather.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Westphalia), small beetles and bees; in one flower there were no less than three individuals of the beetle Meligethes, each in a nectar-secreting angle, while a bee (Halictus nitidus *Schenck* ♀) flew away from a fourth such angle: 3 bees (one Andrena gwynana *K.* ♀, and 2 Halictus leucopus *K.* ♀), nect-skg., were seen in a second flower. Knuth, the honey-bee, freq., skg. Wüstnei (Alsen), the bee Andrena chrysosceles *K.*

2712. G. stellaris Salisb. (= G. arvensis *Schult.*). (Herm. Müller, 'Weit. Beob.,' I, pp. 274–5; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—Warnstorf says that the flowers of this species are protogynous. The stamens are sometimes longer, sometimes shorter than the style, and sometimes the anthers are at the same level as the stigma.

Visitors.—Herm. Müller observed the following in Thuringia.—

A beetle (Meligethes sp.), nect-lkg.; an ant (Lasius niger *L.* ☿) remaining in the same nectar-secreting angle, and being an unbidden guest; 7 bees—1. Andrena albicrus *K.* ♂, skg.; 2. A. gwynana *K.* ♀, do.; 3. Apis mellifica *L.* ☿, do.; 4. Halictus

[1] *Cf.* the foot-note to Leucojum aestivum *L.*

albipes *F.* ♀, skg. and po-cltg.; 5. H. cylindricus *F.* ♀, do.; 6. H. flavipes *F.* ♀, do.; 7. H. nitidiusculus *K.* ♀, do.

2713. G. bracteolaris Salisb. (= G. pratensis *Schult.*). (Warnstorf, op. cit.)—Warnstorf describes the flowers of this species as feebly protogynous. The stamens are at the same level as the stigma or somewhat lower; when the flower closes (after 5 p.m.) autogamy can easily take place. The pollen-grains are golden-yellow in colour, almost ellipsoidal, up to 90 μ long and 37 μ broad. When treated with sulphuric acid the protoplasmic contents ooze slowly out of one pole.

Visitors.—Loew (Brandenburg, 'Beiträge,' p. 34) only observed the bee Andrena albicans *Müll.* ♂, skg.

2714. G. saxatilis Schult. (Schulz, 'Beiträge.')—This species is also feebly protogynous, and pseudo-cleistogamous autogamy takes place in dull weather. At times no fruits are set.

2715. G. Liotardi Schult. (Herm. Müller, 'Alpenblumen,' p. 43.)—The flower mechanism of this species agrees with that of G. fascicularis, but the flowers are homogamous. Autogamy takes place if insect-visits fail, but in sunny weather visitors are numerous.

Visitors.—Herm. Müller observed 3 Hymenoptera, 17 Diptera, 2 Lepidoptera, and Thrips.

2716. G. spathacea Salisb.—

Visitors.—Alfken (Bremen) observed 4 bees—1. Andrena albicans *Müll.* ♀; 2. A. parvula *K.* ♀ and ♂; 3. Halictus minutus *K.* ♀; 4. Nomada fabriciana *L.* ♂.

873. Fritillaria L.

Large, protogynous flowers with concealed nectar secreted by the perianth-leaves. Sometimes inclined to andromonoceism (F. imperialis *L.*, and F. atropurpurea).

2717. F. Meleagris L. (Knuth, Humboldt, Stuttgart, vi, 1887, p. 393, viii, 1889, p. 355; Loew, 'Blütenbiol. Floristik,' p. 353.)—I was able to examine the mechanism and visitors of the beautiful flowers of this species in Wulfshagen near Gettorf, where they grow in thousands in a meadow. Loew describes the large, pendulous flower-bell as being 37 mm. long and 20 mm. broad; it is contracted below into an ovoid shape. It is here commonly called 'plover's egg' ('snake's-head' in England), on account of its shape, size, and marking. There are small light- and dark-purple squares on a white-reddish background, arranged in vertical and horizontal rows. I rarely found flowers which were pure white in colour, or had purple spots on the flower stalk. The inner parts of the flower are protected from rain by its pendulous position, and the close apposition of the perianth leaves. Nectar is secreted in a longitudinal groove on each perianth leaf, beginning about 8 mm. above the base of the leaf and continuing as a shallow furrow almost to its tip. At Wulfshagen the flowers were protogynous; Loew found the same to be the case in cultivated specimens in the Berlin Botanic Garden. The stigmatic papillae are developed when the flower opens, while the anthers are still closed.

Kerner states that if cross-pollination does not take place during the five days of anthesis, autogamy is effected as a last resort. One of the six stamens then usually

elongates, so that its anther is at the same level as the still receptive stigma, and then dehisces, while the other five remain shorter and have already scattered their pollen. Automatic self-pollination by fall of pollen from the latter is excluded, because the papillose stigmatic surfaces are situated on the inner side of the stylar lobes.

Besides these normal flowers occasional blossoms with a gamophyllous perianth occur at Wulfshagen. The circumference of these is the same from stalk to tip, so that they are cylindrical ; they are easily distinguishable from normal flower-buds, as the latter are conical in form. Humble-bees cannot pollinate these abnormal flowers, as the entrance is too small to admit them. It is therefore possible that this is a cleistogamous accessory type of the normal flower; I have, however, been unable to determine whether such flowers are fertile.

Visitors.—Knuth makes the following remarks on these.—

During one hour on the 15th of May, 1887, I observed in more than 20 cases Bombus terrester *L.* ♀ and ☿. This humble-bee alights on the outside of a perianth-leaf, then creeps round on its lower margin into the inside of the flower and climbs up on the inner surface of the leaf until it can lick nectar conveniently. In doing so it brushes against the already receptive stigma in younger flowers with its back and dusts it with pollen brought from older flowers, thus crossing separate stocks. In older flowers also cross-pollination is ensured by insect-visits, because the stigma projects a little beyond the anthers, and is therefore brushed against first by a humble-bee visitor, which in climbing higher dusts its back with fresh pollen.

This was the most usual way in which the humble-bee behaved in visiting a flower, but I also observed another method ; the insect did not then creep up on the inner surface of the perianth leaf, but climbed up the style and the stamens and sought in vain at the base of the latter for nectar. It thus brushed against the stigma and anthers with the lower-side of its body and effected crossing.

2718. F. imperialis L. (Sprengel, 'Entd. Geh.,' pp. 189–91 ; Herm. Müller, 'Weit. Beob.,' I, p. 275; Knuth, 'Bloemenbiol. Bijdragen'; Borbás, Öst. Bot. Zs., Wien, xxxv, 1885.)—Borbás observed heterostyly in this species.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Borgstette (Nassau), the honey-bee. It uses the stigma as an alighting-platform, creeps over the anthers into the nectariferous base of the flower, and then flies straight away to another flower, upon the stigma of which it deposits pollen. Knuth (Kiel Botanic Garden), the honey-bee, freq. Loew (Berlin Botanic Garden), the honey-bee and 3 other bees—1. Anthophora pilipes *F.* ♀, skg.; 2. Bombus hortorum, *L.* ♀, do. ; 3. Andrena fulva *Schr.* ♀, po-cltg. ('Blütenbiol. Beiträge,' II, p. 68).

2719. F. kamtschatcensis Ker-Gawl.—

Visitors. — Loew (Berlin Botanic Garden) observed the Muscid Calliphora erythrocephala *Mg.*, creeping down to the nectaries, and creeping out again with its thorax yellow with pollen.

2720. F. latifolia Willd.—

Visitors.—Loew (Berlin Botanic Garden) observed the bee Andrena fulva *Schr.* ♀, creeping right into the flowers, po-cltg.

2721. F. lutea Mill.—

Visitors.—Loew (Berlin Botanic Garden) observed the humble-bee Bombus terrester *L.* ♀, creeping into the flowers, po-cltg.

874. Lilium Tourn.

Homogamous or feebly protandrous or protogynous lepidopterid flowers, secreting nectar in a furrow at the base of each perianth leaf.

2722. L. Martagon L. (Sprengel, 'Entd. Geh.,' pp. 187–9; Delpino, 'Ult. oss.,' II, pp. 283–4; Herm. Müller, 'Alpenblumen,' pp. 47–8, Nature, London, xii, 1875, pp. 50–1, Kosmos, Leipzig, iii, 1878, 'Weit. Beob.,' I, pp. 275–7; A. and C. Dodel-Port, 'Anatomisch-physiol. Atlas d. Botanik'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. I, II, p. 311; Knuth, 'Bloemenbiol. Bijdragen.')—The nodding flowers of this species are chiefly adapted for pollination by moths, and in a less degree by butterflies. They are homogamous, or, according to Kerner, incompletely protogynous. During the day they are only feebly fragrant, and butterflies are attracted by the dirty-bright-purple perianth, marked with darker purple spots, very occasionally merged into one another; moths are, however, attracted by the odour of nectar, which becomes much stronger in the evening.

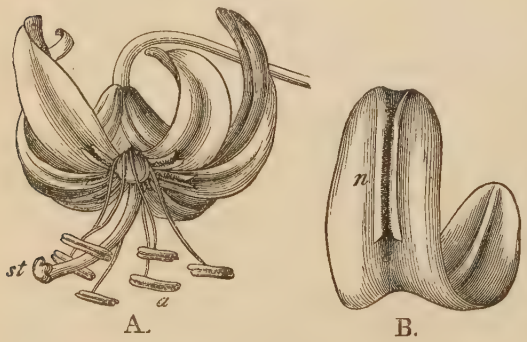


FIG. 394. *Lilium Martagon*, *L.* (after Herm. Müller). *A.* Lateral view of a flower of the natural size and in the natural position. *B.* A single perianth leaf (× 2). *a*, anthers; *n*, nectary; *st*, stigma.

At the base of each perianth leaf there is a nectar-groove 10–15 mm. long, which closes up by the folding together of its edges and a thick growth of reddish hairs, into a narrow, nectar-filled tube. At the outer end there is an opening one mm. in diameter.

When nocturnal hawk-moths searching for nectar alight on the flower, they first touch with the under-side of their bodies the stigma projecting a little beyond the anthers and then the pollen-covered anthers themselves. These are, as in Lonicera Periclymenum, only united at one point with the filaments, and therefore swing freely when touched by the legs of the lepidopterid sucking nectar without alighting on the flower, and dust the lower-side of its body with fresh pollen.

Butterfly visitors are less successful cross-pollinators, as, according to Hermann Müller's observations in the Alps, they creep round on the flower and settle to suck nectar. They only effect crossing occasionally.

Should insect-visits fail, automatic self-pollination may take place by fall of pollen. Kerner says that this happens towards the end of anthesis by the bending of the style until the stigma comes into contact with one or two anthers; such crossing, however, does not take place if cross-pollination has already been effected. This autogamy is effective, as was already realized by Sprengel. Warnstorf describes the pollen-grains as red-brown in colour, biscuit-shaped, with a furrow and a network of ridges; 31 μ broad and 100 long.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Vosges and Alps), the humming-bird hawk-moth (Macroglossa stellatarum *L.*); also 10 other sp. of Lepidoptera in the Alps. Knuth (gardens at Kiel) saw the same hawk-moth flying continuously from flower to flower, and pollinating a large number. Delpino observed a hawk moth, probably Deilephila euphorbiae *L.*

2723. L. bulbiferum L. (Sprengel, op. cit., p. 189; Herm. Müller, 'Alpenblumen,' pp. 45–7; Focke, 'Beob. an Feuerlilien'; Neubert, Tagebl. 52. Vers. D. Natf. in Baden-Baden, 1879; Kerner, op. cit., II, p. 461; Knuth, op. cit.)—The flowers of this species are adapted for pollination by butterflies. In spite of the flame-coloured perianth, which gleams very brightly in sunshine, the odourless blossoms very rarely attract butterflies to the nectar abundantly secreted in the nectar-grooves of the perianth leaves. Anthers and stigma mature simultaneously and are at the same level; the latter is slightly bent down below the former. A lepidopterid

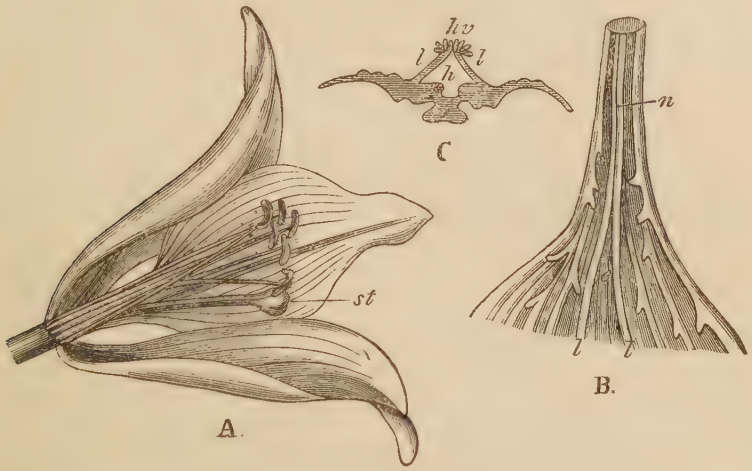


FIG. 395. *Lilium bulbiferum*, *L.* (after Herm. Müller). *A.* Partly dissected flower (× ⅔). *B.* Basal part of a perianth leaf (× 1½). *C.* Transverse section through the base of a perianth leaf (× 5¼). *h*, nectar-groove; *hv*, hairs closing do.; *l*, ridges bearing do.; *n*, nectary; *st*, stigma.

alighting on the lower perianth-leaf and probing thence for nectar will first brush against the stigma and then touch the anthers, thus regularly effecting cross-pollination.

Should insect-visits fail, automatic self-pollination is sometimes possible by contact of anthers and stigma; this, however, is rare or ineffective. Neubert says that the species is always self-sterile. Focke (Öst. Bot. Zs., Wien, xxvii, 1878) describes the variety *croceum* Chx. as self-sterile, and infertile even when dusted with pollen from plants of the same origin, being only fertile when the pollen comes from those of different origin. Crossing is effective in the variety *Buchenavii* Focke, which as regards fruit is a sub-species between L. bulbiferum and L. croceum. In explanation of this behaviour on the part of *croceum*, Focke supposes that the self-sterile plants have all arisen from a single specimen by vegetative means. Kerner states that the variety sets fruits and germinable seeds regularly, but produces no bulbils in the axils of the foliage leaves; this occurs almost regularly in the type species, which,

however, rarely sets fruits. Maximovicz says that when L. dahuricum and the variety *croceum* are crossed, the latter produces fruits corresponding to those of the former, and *vice versâ*.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth (Gardens at Kiel), the peacock butterfly (Vanessa io *L.*). Herm. Müller (Alps), skg. butterflies belonging to the genera Polyommatus and Argynnis, and of the same colour as the flowers of the species.

2724. L. candidum L. (Knuth, op. cit., 'Beiträge,' VI.)—I illustrate the flower mechanism of this plant, which has been grown in cottage gardens for centuries, from specimens obtained in gardens in Kiel. The very large, white flowers are infundibulo-campanuliform and horizontal. They are faintly fragrant by day, much more strongly so in the evening, almost like lilies of the valley. The base of each petal is green and contracted into a sort of groove, in which a rather large drop of nectar is secreted. Automatic self-pollination is excluded in spite of homogamy, as the stigma projects 20–5 mm. beyond the anthers. The white colour, greater fragrance in the evening, and versatile anthers indicate that the flowers are adapted for pollination by nocturnal hawk-moths, especially as no other insects correspond in size to the flowers, and there is no platform provided for visitors. When a visit takes place, the insect cannot avoid touching the stigma, which dominates the entrance of the flower, owing to a slight upward bend in the terminal part of the style, and dusts it with pollen if another flower has previously been visited. On penetrating further into the flower, the anthers, 14 mm. long and 4 mm. broad, and very rich in pollen, brush against the front part of the under-side of the insect's body and dust it again with pollen; the pollen-grains are yolk-yellow in colour, with a network of tubercles, on an average 90 μ long and 60 μ broad. Tinzmann describes the plant as self-sterile.

Fig. 396. *Lilium candidum*, *L.* (from nature). The perianth and 4 of the 6 stamens are removed. The receptive stigma projects about 25 mm. beyond the anthers (natural size).

Visitors.—Knuth makes the following remarks on these.—

In spite of careful watching on warm, still summer evenings, I have never observed hawk-moths, the characteristic and legitimate pollinators. In Rügen (July, '96) I saw a hover-fly (Syrphus pyrastri *L.*) dvg. the pollen that had fallen in the perianth, without touching the stigma or anthers. In Kiel Botanic Garden (August, '98) I saw Apis mellifica *L.* ☿, occasional, po-cltg., also numerous flower-beetles (Meligethes), small black ants, and Thrips. These guests could only occasionally effect self- or cross-pollination.

2725. L. testaceum Lindl. (Knuth, 'Beiträge,' VI.)—The mechanism of this species agrees essentially with that of L. Martagon *L.*, but the flowers are protandrous. They are feebly fragrant, and face obliquely downwards in consequence of a strong curving of the peduncle. In plants which I observed in the Botanic Garden of the Oberrealschule in Kiel, the perianth leaves were rolled back and provided internally with a longitudinal groove, bright wax-yellow in colour, and

marked towards the base with numerous small, projecting, longitudinal streaks of dark-orange colour. Nectar is secreted fairly abundantly at the bases of the six perianth leaves. The anthers are about 16 mm. long and 5 mm. broad, and depend from filaments 30–5 mm. long; soon after the flower opens they are thickly covered with orange-red pollen, the grains of which are on an average 80 μ long and 50 μ broad, agreeing with those of the preceding species as regards shape and surface.

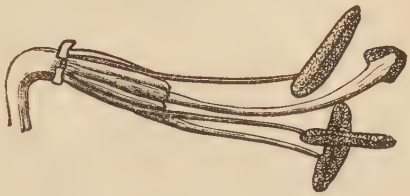


FIG. 397. *Lilium testaceum, Lindl.* (from nature). Flower in the second (hermaphrodite) stage of anthesis. The perianth and 3 stamens have been removed. The mature stigma projects but little beyond the anthers, which are somewhat reflexed (natural size). The stamens have been displaced to some extent, and the anthers hang down more in actual specimens.

At the beginning of anthesis the stigma is still immature, and is situated on a vertical style between the already dehiscent and pollen-covered anthers. Later the style elongates a little, and bends so that the now mature stigma projects laterally from the stamens, and though in pushing through the latter, it gets covered with pollen, if it subsequently receives foreign pollen this always proves prepotent in action.

VISITORS.—I have not observed any, but they may be diurnal hawk-moths (i. e. Macroglossa) as there is no platform and the nectar is only accessible to long-tongued insects hovering in front of the flower without settling.

2726. L. chalcedonicum L. (Knuth, op. cit.)—The flowers of this species open in the morning. The scarlet perianth leaves, which are rolled backwards, possess raised longitudinal streaks from the curved region inwards, and secrete nectar at their grooved bases. In other respects also the flower mechanism agrees essentially with that of the last species, though protandry is but slight, and the stigma remains in contact throughout anthesis with the pollen-covered anthers, 14 mm. long and 5 mm. broad, so that automatic self-pollination takes place still more certainly. The pollen-grains are orange-red in colour, with a network of tubercles, on an average 90 μ long and 50 μ broad.

VISITORS.—As the last species.

2727. L. tigrinum Ker-Gawl.—In this species the orange-red perianth leaves are reflexed, marked with numerous black-purple spots, and provided with almost prickly papillae on the way to the nectar secreted in the usual place. The large, dark-brown stigma at the tip of a style 6 cm. long, is situated at first between the 6 anthers, which are 2 cm. long and 4 mm. broad, and thickly covered with dark-brown pollen. Automatic self-pollination, however, cannot take place, as the anthers are several centimetres distant from the stigma, and the line of fall of the pollen passes this by. Later on, the style bends upwards, so that the stigma comes into contact with one pollen-covered anther, and autogamy can be effected. In bending upwards thus the style appears to make rotatory movements, rendering it still easier to bring the stigma into contact with one of the two upper anthers.

The species provides for vegetative propagation by producing large, black bulbils in the leaf-axils.

VISITORS.—I did not observe any on the hot, calm morning of August 16, 1898,

in the garden of the Oberrealschule in Kiel. Even the honey-bee and Bombus terrester *L.* ☿, which visited the adjacent flowers of other plants busily sucking and collecting pollen, despised the odourless ones of this lily. In its native countries (China and Japan) it may be pollinated by diurnal hawk-moths.

2728. L. auratum Lindl.—Stadler ('Beiträge') states that the flowers of this species are protogynous, and adapted for pollination by crepuscular and diurnal Lepidoptera.

2729. L. philadelphicum L. (=L. umbellatum *Pursh*).—Stadler (op. cit.) says that this species agrees with L. bulbiferum *L.*, and L. Martagon *L.* as regards the structure of its nectaries.

875. Lloydia Salisb.

Protandrous flowers with exposed nectar.

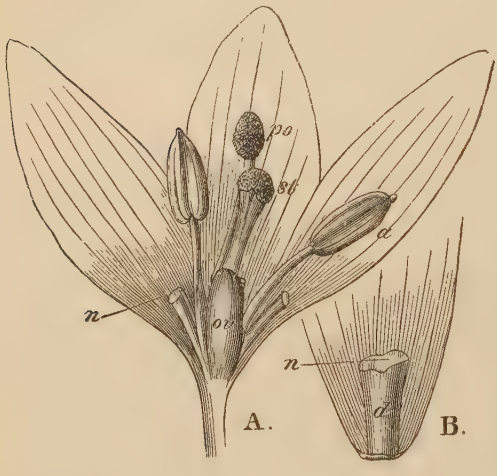


FIG. 398. *Lloydia alpina*, *Salisb.* (after Herm. Müller). *A.* Partly dissected flower (× 5). *B.* Base of a perianth leaf, with its nectary (× 7). *a*, anthers; *d*, dark-yellow swelling; *n*, nectary with its secretion; *ov*, ovary; *po*, pollen; *st*, stigma.

2730. L. alpina Salisb. (=L. serotina *Sweet*). (Ricca, Atti Soc. ital. sc. nat., Milano, xiii, 1870; Herm. Müller, 'Alpenblumen,' pp. 43–5.)—The flowers of this species are adapted for pollination by flies. Hermann Müller describes them as feebly, Ricca as markedly, protandrous, and therefore favourable to cross-pollination by insect-visits. Nectar is secreted by a thick ridge at the base of each perianth leaf, and is accessible to short-tongued insects. Automatic self-pollination takes place now and then.

VISITORS.—Herm. Müller (Alps) observed 7 Diptera, a beetle, and 3 short-tongued Hymenoptera.

876. Erythronium L.

Bee and lepidopterid flowers.

2731. E. Dens canis L. (Calloni, Malpighia, Messina, i, 1886–7, pp. 14–19; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 311; Loew, 'Blütenbiol. Floristik,' pp. 354–5.)—This species is indigenous to the mountain forests of Carniola, Steiermark, Bohemia, Hungary, &c., and bears bright-purple, more rarely white pendulous flowers. The perianth leaves are reflected above, and fold together at the base like a bell, thus forming a short, nectar-holding tube. Each of the petals possesses a basal swelling, divided into projections by furrows. Calloni says that this is the nectary; Loew, however, considers that this collar-like ligular structure is only a nectar-cover, preventing the nectar secreted at the base of the

perianth below it from trickling down, which would otherwise happen in consequence of the pendulous position of the flower. Loew states that narrow grooves in the middle of the petals and covered by the filaments serve as nectar-passages.

Calloni describes the flowers as homogamous, Kerner as incompletely protogynous. The former considers the plant anemophilous on account of its long, projecting stamens and broad stigma, and at the same time entomophilous because of the bright colouring of the flowers and their secretion of nectar. Loew is of the opinion that the whole flower mechanism indicates only entomophily, and that the difficulty of access to the nectar points to the visits of the more skilful bees and lepidoptera.

Briquet (Mém. soc. sci. nat., Cherbourg, xxx, 1896) has re-examined the flower on account of the differing opinions of Calloni and Loew regarding its mechanism, and essentially confirms Loew's view, writing as follows.—'The brilliantly coloured perianth possesses distinct nectar-guides. A pit-shaped nectary is situated at the base of each of the three sepals, and is related to the nectar-passage formed by the bases of the petals. A collar-shaped ligular structure at the base of the petals forms a nectar-cover, which at the same time covers the nectar-passage.'

Visitors.—These are bees, which chiefly effect cross-pollination, this being favoured by the feeble protogyny of the flower.

2732. E. Smithii Hook.—Briquet (op. cit.) describes the flowers of this species as possessing a similar mechanism to E. Dens-canis. Some American species, however, diverge in certain respects.

877. Dracaena Vaud.

2733. D. Goldieana Hort.—Marion ('Note sur la floraison du Dracaena Goldieana') says that this species bears night-flowers. They open their white perianths towards evening, and diffuse a penetrating, pleasant odour of lilies. They are markedly protogynous.

878. Yucca Dill.

Riley (*vide* Bibliography, Vol. I, pp. 336–7, Nos. 2934–6, 2941–5, 2947, 2950–1) states that the pollen is stuffed into the stigmas of all capsular species of this genus by the Yucca moth (Pronuba yuccasella *Riley*) in order that the larvae, on emerging from the eggs, may obtain the nourishment necessary for their sustenance. The moth lays her eggs in the pistil of the flower, in the neighbourhood of the ovules (*cf.* Vol. I, pp. 102–3).

879. Eremurus Bieb.

2734. E. spectabilis Bieb.—Hildebrand (Flora, Marburg, xxxix, 1881) says that the flowers of this species lose their colour before the anthers and stigma mature.

Regarding this Hermann Müller says (Bot. Ztg., Leipzig, xl, 1882).—'The flowers lose their conspicuousness before the maturation of the stigmas and anthers. As in the case of Weigelia, Lantana, and many other flowers undergoing a colour-change, the gain here is that the less intelligent and useless guests are attracted away to the more conspicuous flowers which contain no treasure for them.

Visitors.—Hildebrand (Ber. D. bot. Ges., Berlin, x, 1892), in the Freiburg i. B. Botanic Garden, observed the honey-bee, skg.; it may therefore be concluded that in its native country the plant is pollinated by bees.

2735. E. altaicus Pall.; **2736. E. caucasicus** Stev. (=E. spectabilis *Bieb.*, according to the *Index Kewensis*); and **2737. E. tauricus** Stev.—Dammer saw the first of these species pollinated by Syrphus pyrastri *L.* (Flora, Regensburg and Marburg, lxxi, 1888). Kerner says that in all three species ('Nat. Hist. Pl., Eng. Ed. 1, II, p. 327) the perianth leaves roll up as soon as the anthers dehisce, fade, and form a dirty red-brown crumpled mass, from which the juicy midribs at the backs of the leaves project as six thick, greenish swellings. These resemble aphides in appearance, and a hover-fly, Syrphus pyrastri *L.*, seems to take them for such, for it pounces upon the curled-up flowers in exactly the same way as it attacks such insects. In doing so it becomes covered with pollen from the anthers situated in front of the flower, and transfers it to the stigmas of others. Kerner (op. cit., II, p. 326) adds that in the case of E. caucasicus geitonogamy sometimes takes place, for the stigmas situated at the tip of the elongating style may come into contact with the pollen-covered anthers of flowers situated higher on the inflorescence; many, however, do not attain such contact and, as insect-pollination is rare, but few fruits are set. In order to give pollination the best possible chance, the stigmas are extremely persistent, remaining receptive from the moment the flower opens until long after the fading of the anthers and the curling up of the perianth leaves.

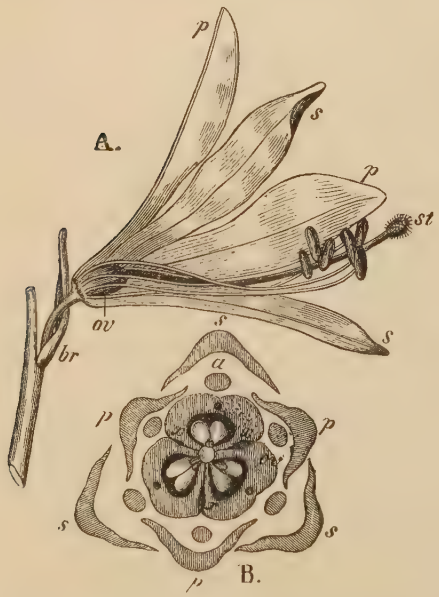


Fig. 309. *Paradisea Liliastrum, Bertol.* (after Herm. Müller). *A.* Flower after removal of the right half of the perianth; seen from the right side (natural size). *B.* Transverse section through the lower part of a flower, at the level of the ovary. *a*, anterior stamen (in section); *br*, bract; *ov*, ovary; *p*, petals; *s*, sepals; *st*, stigma; *x*, probable nectaries.

880. Paradisea Mazzin.

Moth flowers, with nectar secreted by the ovary.

2738. P. Liliastrum Bertol. (Herm. Müller, 'Alpenblumen,' pp. 48–50; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 301.)—In the snow-white flowers of this species the stigma projects beyond the anthers, so that insects on alighting touch it first, and so effect crossing.

Visitors.—Herm. Müller observed the moth Plusia gamma *L.*, also, as unbidden guests, a bee, a saw-fly, a Muscid, and 2 beetles.

881. Anthericum L.

White flowers with exposed nectar, secreted by the upper part of the ovary. Kerner ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 304) says that in Phalangium *Juss.*

(=Anthericum *L.*) the stigma is at first situated in front of the anthers at the end of the greatly projecting style, so that an insect visitor must brush against it first; later on the style bends laterally at an angle of 80–90°, the stigma being thus removed from the line of approach to the nectar, and insect visitors enabled to touch the pollen-covered anthers.

2739. A. ramosum L. (Sprengel, 'Entd. Geh.,' pp. 196–8; Herm. Müller, 'Fertlsn.,' p. 552, 'Weit. Beob.,' I, p. 282; Kirchner, 'Flora v. Stuttgart,' p. 65; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The homogamous (or, according to Warnstorf, protogynous) flowers of this species expand to a star about 25 mm. in diameter. The stigma projects a little beyond the anthers, so that insects probing for the exposed nectar first touch this and then the anthers, cross-pollination being thus favoured. If insect-visits fail, automatic self-pollination can take place by fall of pollen in flowers which are directed obliquely downwards. Warnstorf describes the pollen-grains as large, ellipsoidal, with pointed poles, and a network of tubercles up to 87 μ long and 39 μ broad.

Visitors.—Herm. Müller observed the following in Central Germany.—

A. Coleoptera. (*a*) *Cerambycidae*: 1. Strangalia bifasciata *Müll.*, skg. (*b*) *Telephoridae*: 2. Dasytes flavipes *F.*, skg. (*c*) *Oedemeridae*: 3. Oedemera virescens *L.*, skg. **B. Diptera.** (*a*) *Empidae*: 4. Empis livida *L.*, freq., skg. (*b*) *Muscidae*: 5. Anthomyia, sp., skg. (*c*) *Syrphidae*: 6. Merodon aeneus *Mg.*, skg. and po-dvg., also *in copulâ*; 7. Volucella bombylans *L.*, skg. **C. Hymenoptera.** (*a*) *Apidae*: 8. Apis mellifica *L.* ☿, very common, skg. and po-dvg.; 9. Bombus pratorum *L.* ☿, skg.; 10. Halictus albipes *F.* ♂, do.; 11. H. longulus *Sm.* ♂, do.; 12. H. maculatus *Sm.* ♀, skg. and po-cltg.; 13. H. pauxillus *Schenck* ♂, skg. (*b*) *Formicidae*: 14. Formica fusca *L.* ☿, nect-lkg.; 15. Lasius niger *L.* ☿, nect-lkg. (*c*) *Sphegidae*: 16. Cerceris quinquefasciata *Rossi*, skg.; 17. C. variabilis *Schr.* **D. Lepidoptera.** (*a*) *Rhopalocera*: 18. Coenonympha arcania *L.*, skg.; 19. Melitaea athalia *Rott.*, do.; 20. Papilio machaon *L.*, do.; 21. Pieris rapae *L.*, do. (*b*) *Sphingidae*: 22. Ino globulariae *Hbn.*, do.; 23. Zygaena achilleae *Esp.*, do.; 24. Z. lonicerae *Esp.*, do.

2740. A. Liliago L. (Herm. Müller, 'Weit. Beob.,' I, p. 282; Kirchner, 'Flora v. Stuttgart,' p. 66.)—The flower mechanism of this species agrees entirely with that of A. ramosum, but the flowers are larger, their diameter being 35–40 mm. Ricca (Atti Soc. ital. sc. nat., Milano, xiv, 1871) states that the stigma projects a little beyond the anthers, and that nectar is scanty.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Ricca, bees. Herm. Müller (Thuringia).—**A. Coleoptera.** *Elateridae*: 1. Agriotes gallicus *Loc.*, skg. **B. Diptera.** *Empidae*: 2. Rhamphomyia sp., skg. **C. Hymenoptera.** *Apidae*: 3. Apis mellifica *L.* ☿, skg. and po-cltg. MacLeod (Pyrenees), a hover-fly (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 304).

882. Asphodelus L.

White, usually protogynous flowers with concealed nectar secreted by the ovary; they are arranged in racemose inflorescences.

2741. A. ramosus L. (=A. albus *Mill.*). (MacLeod, 'Pyreneënbl.,' pp. 301–4.)—In flowers of this species the six stamens broaden at their bases, and their apposed margins form a nectar-receptacle, surrounding the fluid abundantly secreted by the

three corners of the ovary. There are six entrances to this at the base of the style, one between every pair of stamens. These entrances to the nectar are so narrow that MacLeod is inclined to put the flowers into class **L.** They are feebly protogynous. At first the perianth lobes are close together, so that only the stigma is touched by visitors. They soon diverge, however, and the anthers dehisce after the filaments have bent widely outwards. As the stigma projects about 4 mm. beyond the anthers, self-pollination is no doubt excluded.

Visitors.—MacLeod (Pyrenees) only observed 2 flies, and did not see the normal visitors (Lepidoptera).

2742. A. fistulosus L. (Knuth, 'Blütenbiol. Beob. a. d. Ins. Capri.')—The flowers of this species are very little visited by insects on the island of Capri, as the many-flowered, branching inflorescences always set but few fruits. Automatic self-pollination is therefore impossible or ineffective.

883. Asphodeline Reichb.

2743. A. lutea Reichenb. (=Asphodelus luteus *L.*). (Francke, Inaug.-Diss., Halle, 1883.)—Francke says that the flowers of this species are protogynous for some hours, and then homogamous.

884. Ornithogalum L.

Literature.—Kirchner, 'Flora v. Stuttgart,' p. 58; Grassmann, 'Die Septaldrüsen.'

Flowers pale yellow-green in colour, or white inside and mostly green outside, with half-concealed nectar secreted by three septal glands in the ovary. These contract above and form a narrow passage leading outwards, through which the secretion exudes and trickles down the furrows of the ovary. Sometimes gynodioecism.

2744. O. umbellatum L. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 311; Kirchner, 'Flora v. Stuttgart,' p. 59; MacLeod, Bot. Jaarb. Dodonaea, Ghent, iv, 1892; Warnstorf, Schr. natw. Ver., Wernigerode, xi, 1896.)—In flowers of this species the perianth leaves are milk-white inside and green outside, with a narrow white margin. In sunny weather they expand to a star 30–45 mm. in diameter. They are protogynous, but the stigma is still receptive when the anthers dehisce. Kirchner states that of the six stamens the anthers of the three outer ones dehisce first, and then those of the three inner ones. At first all the stamens are stretched straight out; after dehiscence the upper halves of the filaments bend gradually outwards, while the lower halves remain apposed to the ovary. In this way six narrow canals are formed, of which the three apposed to the septal glands contain nectar. The flowers close after midday and in dull weather, so that automatic self-pollination now takes place in older flowers by contact of anthers and stigmas. According to Kerner's description, on the contrary, the anthers of the three inner, longer stamens dehisce a day earlier than those of the outer, shorter ones, and I can confirm this from plants in the garden of the Oberrealschule in Kiel. Insect-visits are necessary for pollination at first, in consequence of the 2 mm. distance between anthers and stigma; towards the end of anthesis the stamens bend so far inwards that anthers and stigma come into contact, and automatic self-pollination takes place. Kirchner observed stocks bearing flowers in which the anthers always remained closed, these being therefore functionally female. Warnstorf describes the

pollen-grains as bright-yellow in colour, feebly tuberculate, ellipsoidal, longitudinally furrowed, up to 70 μ long and 30 μ broad, adhering for a long time to the walls of the anther-valves.

Visitors.—MacLeod (Flanders) observed the honey-bee, 3 short-tongued bees, an Empid, and the beetle Meligethes.

2745. O. nutans L. (=Myogalum nutans *Lam.*). (Sprengel, 'Entd. Geh.,' pp. 189–91; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 415.)—The protandrous flowers of this species are vertical while in the bud, and horizontal during the first stage of anthesis, only becoming pendulous towards its end. The anthers of the three stamens situated in front of the small, nectar-secreting pits of the ovary are also dehiscent when the flower opens, and in such a position that they must be brushed against by nectar-seeking insects.

In a later stage the stigma is receptive, and the stamens bend back against the perianth leaves, so that they leave the way clear for visitors. Insects dusted with pollen from younger flowers now brush the stigma in searching for nectar, and thus effect crossing.

In the third and last stage of anthesis the peduncle bends so that the blossom becomes pendulous. The stamens are now again bent towards the middle of the flower, and the stigma is situated just below the anthers of the shorter stamens, which still contain pollen, having dehisced during the second stage of anthesis, and so moved their position that nectar-seeking insects were unable to rob them of pollen. The anthers next gradually shrivel up, automatic self-pollination still taking place by fall of pollen. Should insect-visits still take place either cross- or self-pollination is possible.

2746. O. Boucheanum Aschs. (=O. nutans *L.*, according to the *Index Kewensis*).—

Visitors.—Loew (Berlin Botanic Garden) observed the Telephorid beetle Cantharis rustica *Fall.*, settling.

2747. O. affine Schult.—

Visitors.—Loew (Berlin Botanic Garden) observed 2 bees—1. Anthophora pilipes *F.* ♂, inserting its proboscis between the anthers; 2. Apis mellifica *L.* ☿, skg., inserting its proboscis to the bases of the widened anthers.

2748. O. refractum *Willd.*—

Visitors.—Schletterer (Pola) observed the small bee Andrena parvula *K.*

2749. O. pyrenaicum L. (=O. sulfureum *Schult.*).—The flowers of this species are pale-green in colour.

Visitors.—Plateau (Belgium) observed 2 bees—the honey-bee and Prosopis sp.

885. Scilla L.

Flowers generally blue, rarely lilac or white in colour; homogamous or protogynous; with exposed to half-concealed nectar, secreted by the septal glands of the ovary, and collecting between this organ and the bases of the filaments.

2750. S. bifolia L. (Kirchner, 'Flora v. Stuttgart,' p. 59.)—The oblique or horizontal flowers of this species expand to a star about 20 mm. in diameter. The anthers, covered with grey pollen, are at the same level as the simultaneously maturing stigma, but so far removed from it that automatic self-pollination does not at first

take place, cross- and self-pollination being effected by small insects. The flower closes when it fades, autogamy then taking place by contact of stigma and anthers.

Visitors.—Kirchner observed small flies.

2751. S. sibirica Andr. (Herm. Müller, 'Weit. Beob.,' I, p. 279; Knuth, 'Bloemenbiol. Bijdragen'; Warnstorf, Schr. natw. Ver., Wernigerode, xi, 1896.)—Warnstorf describes the flowers of this species as protogynous. The three rows of diverging stigmatic papillae are situated at the same level as the beautiful blue, introrse anthers. The filaments are inserted into the middle of the backs of the anthers. The pollen-grains are blue, opaque, irregularly ellipsoidal, up to 65 μ long and 30 μ broad.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Thuringia), the honey-bee, freq., skg. Knuth (Kiel Botanic Garden, 29. 3.'94), the honey-bee Apis mellifica *L.* ☿, and (21. 3.'96) the butterfly Vanessa urticae *L.*, both freq., skg. Loew (Berlin Botanic Garden), the honey-bee, boring for sap at the base of the ovary with the blades of its maxillae. Alfken (Bremen), 8 bees—1. Andrena albicans *Müll.* ♂; 2. Bombus jonellus *K.* ♀; 3. B. lucorum *L.* ♀; 4. B. pratorum *L.* ♀; 5. B. terrester *L.* ♀; 6. Osmia cornuta *Ltr.* ♀; 7. O. rufa *L.* ♀ and ♂; 8. Podalirius acervorum *L.* ♂. Friese (Baden), the bee Andrena gwynana *K.*, very freq.

2752. S. verna Huds.—

Visitors.—MacLeod (Pyrenees) observed a bee and 3 flies (Bot. Jaarb. Dodonaea, Ghent, iii, 1891, p. 306).

2753. S. amoena L. (Sprengel, 'Entd. Geh.,' pp. 195–6.)—

Visitors.—Loew (Berlin Botanic Garden) observed the honey-bee—Apis mellifica *L.* ☿—boring for sap with its maxillary blades in the base of the ovary.

2754. S. cernua Hffgg.—

Visitors.—As S. amoena.

2755. S. hispanica Mill. (=S. campanulata *Ait.*).—

Visitors.—Loew (Berlin Botanic Garden) observed a hover-fly (Eristalis arbustorum *L.*, po-dvg.), and the honey-bee, behaving as in S. amoena.

2756. S. italica L.—

Visitors.—Loew (Berlin Botanic Garden) observed a Muscid (Scatophaga merdaria *F.*, resting on the outside of the corolla), a hover-fly (Eristalis aeneus *Scop.*), and the honey-bee, behaving as in S. amoena.

2757. S. festalis Salisb. (=S. nutans *Sm.*).—

Visitors.—Loew (Berlin Botanic Garden) observed 2 hover-flies, po-dvg.—Eristalis nemorum *L.*, and Syritta pipiens *L.*

2758. S. patula DC. (=S. hispanica *Mill.*, according to the *Index Kewensis*).—

Visitors.—Loew (Berlin Botanic Garden) observed a humble-bee (Bombus hortorum *L.* ♀, apparently skg.), and a butterfly (Pieris brassicae *L.*) clearly inserting its proboscis into the base of the ovary.

2759. S. tricolor Baker.—

Visitors.—Loew (Berlin Botanic Garden) observed the honey-bee, boring for sap

886. Urginea Steinh.

2760. U. Scilla Steinh. (=Scilla maritima *L.*). (Herm. Müller, 'Weit. Beob.,' I, p. 378.)—

Visitors.—Herm. Müller, jr., observed the following 10 bees, all skg., at Jena.—1. Anthophora aestivalis *Pz.* (= A. haworthana *K.*) ♂ and ♀, po-cltg.; 2. Andrena parvula *K.* ♀; 3. Chalicodoma muraria *Retz.* ♂; 3. Eucera longicornis *L.* ♂ and ♀; 5. Halictus maculatus *Sm.* ♀; 6. Melecta luctuosa *Scop.* ♂ and ♂; 7. Osmia aenea *L.* ♂; 8. O. aurulenta *Pz.* ♀ and ♂; 9. O. fusca *Chr.* (=O. bicolor *Schr.*); 10. Sphecodes gibbus *L.* ♀.

887. Brodiaea Sm.

2761. B. laxa S. Wats. (Borzì, 'Contrib. alla biol. veget.,' II, Fasc. 2, pp. 3–4.)—Borzì describes the flowers of this species as protandrous. Nectar is secreted at the base of the flower.

Visitors.—Small po-cltg. bees (Halictus sp.).

2762. B. Douglasii S. Wats. (Borzì, op. cit., p. 4.)—Borzì describes this species as possessing a similar mechanism to B. laxa.

2763. B. lutea Lindl. (Borzì, op. cit., pp. 4–6.)—Borzì states that in this species there are two kinds of nectary in the same flower differing in position, time of development, and origin, one being present in the male and the other in the female stage. So far as our present knowledge goes this is a unique case.

2764. B. multiflora Benth. (Borzì, op. cit., pp. 7–8.)—In this species the narrow passage to the nectar secreted at the base of the flower leads between the perianth wall and the ovary. The three inner stamens are modified into three small, petaloid staminodes, alternating with the three fertile stamens, and turning their concave sides to the middle of the flower. A mechanism is thus formed which agrees largely with that of Asclepiads.

2765. B. ixioides S. Wats. (Willis, 'Contrib. to the Nat. Hist. of the Flower,' 2.)—The flowers of this species are protandrous.

Visitors.—Willis (Cambridge Botanic Garden) observed the beetle Meligethes, Thrips, and flies.

888. Brevoortia Wood.

2766. B. Ida-Maia Wood. (Borzì, op. cit., pp. 8–9.)—This species possesses a similar flower mechanism to that of Brodiaea ixioides.

889. Stropholirion Torr.

2767. S. californicum Torr. (Borzì, op. cit., p. 9.)—This species possesses a similar flower mechanism to that of Brevoortia Ida-Maia, being only distinguished by its shorter perianth tube.

890. Allium L.

Protandrous (rarely protogynous) flowers, usually aggregated into conspicuous globular umbels; the nectar is concealed, and Grassmann states that it is secreted

by three double septal glands in the ovary and exudes by canals situated about half-way up that organ. The nectar then collects in the spaces between the base of the ovary and those of the three inner stamens. It is also sometimes secreted at the base of the ovary. Many species, such as A. Schoenoprasum, A. vineale, A. Chamaemoly, A. carinatum, A. oleraceum, A. sativum, bear bulbils in the axils of the upper bracts.

2768. A. Victorialis L. (Sprengel, 'Entd. Geh.,' p. 187; Herm. Müller, 'Alpenblumen,' pp. 50–1; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 283, 327.)—In the yellowish-white flowers of this species, aggregated into globular umbels, the pollen-covered anthers project in the first stage of anthesis, and the stigma in the second, so that a nectar-seeking visitor touches one or other, and thus effects crossing. Self-pollination is excluded by marked protandry.

Kerner's description differs from the one above given by Hermann Müller. He says that the pollen clings to the stigma before its papillae are mature, and in a condition to stimulate the growth of pollen-tubes. He also describes each

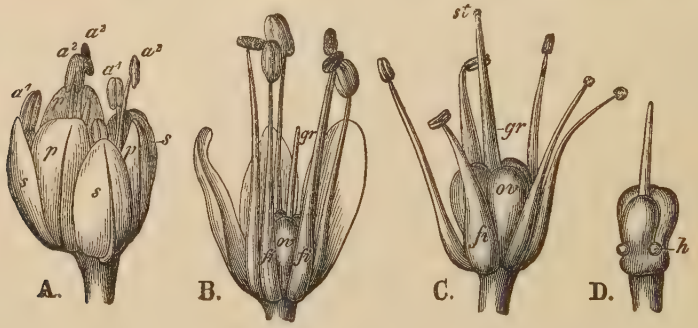


FIG. 400. *Allium Victorialis*, L. (after Herm. Müller). *A.* Lateral view of a flower in the first (male) stage of anthesis. *B.* Do., in a further stage, after removal of part of the perianth. *C.* Reproductive organs in the second (female) stage. *D.* Pistil of a flower in the first stage. $a^1 a^1$, stamens; *fi*, filament; *gr*, style; *h*, nectar; *ov*, ovary; *p*, petals; *s*, sepals; *st*, stigma.

umbel as containing flowers in varying stages of maturation. In younger flowers the anthers are still closed and hidden by the perianth leaves, while the stigmas are already mature and project from the perianth. In the older flowers of the same umbel, however, the pollen-covered anthers are situated above the perianth, so that when the younger, short-stalked flowers are raised by the elongation of their stalks, their stigmas brush against the pollen-covered anthers of the older ones, and are therefore geitonogamously pollinated. Thus according to Kerner's description the flowers examined by him were markedly protogynous, while those described by Hermann Müller in the Heuthal on the Bernina were strongly protandrous.

VISITORS.—Herm. Müller (Alps) observed a beetle, 25 Diptera, 4 Hymenoptera, and 11 Lepidoptera. Loew (Berlin Botanic Garden) saw the honey-bee, skg.

2769. A. ursinum L. (Herm. Müller, 'Fertilisation,' p. 553; Kirchner, 'Flora v. Stuttgart,' pp. 60–1.)—The snow-white perianth in flowers of this species expands in the form of a star. There are six stamens; the anthers of the three inner ones dehisce first, and then those of the three outer. During this time the style, which is at first only 2–3 mm. long, elongates to 6 mm., and the stigma

matures. Insects probing for nectar touch the upwardly dehiscing anthers with one side of their bodies and the stigma with the other, so that cross-pollination is most favoured. Should insect-visits fail, automatic self-pollination may be effected in individual flowers by the bending over of the style towards the anther.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Westphalia), the humble-bee Bombus pratorum *L.* ♀, quickly flying from flower to flower, inserting its proboscis into each to suck nectar, and taking to the wing scarcely 2 seconds later. Loew (Berlin Botanic Garden), the honey-bee, skg. Scott-Elliot (Dumfriesshire), the honey-bee, very freq., also several Muscids and Dolichopodids ('Flora of Dumfriesshire,' p. 172).

2770. A. angulosum L. (= A. acutangulum *Schrad.*). (Schulz, 'Beiträge,' I, p. 98, II, p. 165.)—The rose-red, rarely white flowers of this species are rich in nectar and protandrous to a varying degree; feebly so at Halle, and very markedly at Bozen. There are six stamens, the anthers of the inner ones dehiscing first, and those of the outer later. At Halle, Schulz usually observed self-pollination in the closed flower.

Visitors.—Schulz (Halle) observed flies, bees, and Lepidoptera.

2771. A. fallax Schult. (= A. senescens *Host.*, and A. montanum *F. W. Schmidt*). (Schulz, 'Beiträge,' II, p. 165; Knuth, 'Bloemenbiol. Bijdragen.')—The flowers of this species are of the same colour as those of A. angulorum, and Schulz found them to be feebly protandrous at Bozen. The anthers and stigma project beyond the perianth. Automatic self-pollination is easily possible on account of the proximity of these organs while the flower is closed.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Schulz (Bozen), flies, bees, and Lepidoptera. Knuth (Kiel), the honey-bee, skg. MacLeod (Pyrenees), a humble-bee and 3 flies (Bot. Jaarb. Dodonaea, Ghent, iii. 1891, p. 306).

2772. A. nutans L. (Knuth, 'Bloemenbiol. Bijdragen.')—

Visitors.—Knuth (Kiel Botanic Garden), the bee Podalirius vulpinus *Pz.* ♀, skg.

2773. A. Porrum L. (Sprengel, 'Entd. Geh.,' p. 186; Kirchner, 'Flora v. Stuttgart,' p. 63.)—The whitish or bright pink flowers of this species are aggregated into very large, globular inflorescences, measuring up to 12 cm. in diameter, and consisting of 2–3000 bell-shaped individual blossoms. The flowers possess six stamens, the inner anthers first dehiscing in succession, and then the outer ones. They project about one mm. beyond the perianth. During dehiscence of the anthers the style is short, and concealed in a depression of the ovary, but later on, when the dehisced stamens bend outwards, it elongates to about 3 mm., so that it projects about 2 mm. beyond the perianth.

Visitors.—Kirchner observed the honey-bee and beetles.

2774. A. rotundum L. (Herm. Müller, 'Weit. Beob.,' I, pp. 279–82.)—The small, fragrant, protandrous flowers of this species are purple-red in colour, and crowded into globose umbels 30–40 mm. in diameter. The nectar, secreted by

three shield-shaped, hollowed, nectar-glands at the base of the ovary, is deeply concealed, being completely covered by the broadened inner filaments. First the three inner anthers, and then the three outer ones dehisce in succession. The style does not reach its full length until the latter three have faded, and the stigma is then receptive. The possibility of automatic self-pollination is retained, however, should insect-visits fail, for pollen still adheres to the three outer anthers, which are borne upon narrow filaments, when the stigma is mature. It is then easily possible for the latter to come into contact with the pollen automatically by elongation of the style, or to be dusted by fall of pollen.

A visitor inserts its head from above behind the nectar-cover, and thus in younger flowers touches the pollen-covered anthers, and in older ones the receptive stigma, so that crossing is ensured.

Visitors.—Herm. Müller observed the following in the Mühlberger Schlossberg in Thuringia.—

A. Coleoptera. (*a*) *Curculionidae*: 1. Bruchus olivaceus *Germ.*, not infreq. (*b*) *Telephoridae*: 2. Danacea pallipes *Pz.*, not infreq. **B. Diptera.** (*a*) *Muscidae*: (3) Gonia capitata *Deg.*, undoubtedly skg.; 4. Ocyptera cylindrica *F.*, do.; 5. Olivieria lateralis *Pz.*, do.; 6. Ulidia erythrophthalma *Mg.*, vainly searching for nectar. (*b*) *Tabanidae*: 7. Tabanus rusticus *F.*, freq., skg. (?). **C. Hymenoptera.** (*a*) *Apidae*: 8. Andrena labialis, *K.* ♂, skg.; 9. Apis mellifica *L.* ☿, skg. and po-cltg.; 10. Halictus leucopus *K.* ♀, skg.; 11. H. maculatus *Sm.* ♀, skg. and po-cltg.; 12. Prosopis angustata *Schenck* ♂, skg.; 13. P. communis *Nyl.* ♀ and ♂, freq., do.; 14. P. obscurata *Schenck* ♂, do. (*b*) *Formicidae*: 15. Lasius niger *L.* ☿, creeping for a long time over the flowers, without finding its way in. (*c*) *Sphegidae.* 16. Cerceris labiata *F.* ♂, freq., skg. **D. Lepidoptera.** (*a*) *Rhopalocera*: 17. Lycaena damon *S. V.*, skg. (*b*) *Sphingidae*: 18. Zygaena achilleae *Esp.*, do.

2775. A. sphaerocephalum L. (Herm. Müller, 'Alpenblumen,' p. 52; Schulz, 'Beiträge,' II, pp. 165–6.)—The red-violet or rose-red flowers of this species are still a little less markedly protandrous than those of A. rotundum, for though the style is still short when the inner anthers dehisce, it has elongated by the time the outer ones are mature and the stigma receptive. When the perianth is closed, therefore, automatic self-pollination takes place easily.

Visitors.—The following were recorded by the observers and for the localities stated.—

Schulz, Hymenoptera, flies, Lepidoptera, and beetles. Herm. Müller (Alps), a bee, 2 flies, and a lepidopterid. Loew (Berlin Botanic Garden), the Sphegid Lindenius albilabris *F.* ♀. F. F. Kohl (Tyrol), the wasp Eumenes unguiculata, *Vill.*

2776. A. Chamaemoly L. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 303, 386.)—The small, white flowers of this species possess a fragrance of nectar, and grow very close to the ground on short stalks. The mouth of the flower is at first upwardly directed, and the blossoms are therefore almost concealed among the ribbon-like foliage leaves. The ovary secretes nectar abundantly in three grooves. Kerner states that the flowers are protogynous, thus differing from all other species of Allium hitherto examined. In the first stage of anthesis, the stamens, with anthers still closed, are pressed against the perianth leaves, and the receptive stigma is situated in the entrance of the flower. In the second stage all the stamens bend towards the middle of the flower, the anthers dehiscing at the same time, so that

a close tangle of pollen-covered anthers is situated there, which is touched by that part of the body of an insect probing for nectar with which it brushes against the stigma of a flower in the first stage. Insect-visits therefore ensure crossing. Finally, in the third stage, the peduncle curves downwards so that the flower lies on the earth and automatic self-pollination becomes possible by fall of pollen, or by means of such grains as lie on the perianth leaves.

2777. A. vineale L. (Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 143–4, 167; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—Plants of this species bear almost spherical inflorescences $2\frac{1}{2}$ cm. in diameter, on scapes about $\frac{1}{2}$ m. high, composed of numerous dark-violet protandrous flowers mixed with bulbils. The acutely ovoid flower is closed by the inwardly inclining perianth leaves, and is 5 mm. long and 3 mm. wide at its broadest part. In the first (male) stage the filaments, with transverse anthers, project about 3 mm. from the flower, while the style, with still immature stigma, is concealed. After the exserted parts of the filaments have faded, and the completely emptied anthers have withdrawn into the perianth, the stigma on the elongating style projects, so that it is finally situated 3 mm. above the flower. Nectar is found at the base of the ovary in both stages, collected in a little pocket at the bottom of the perianth leaves. Warnstorf describes the pollen-grains as bluish-white in colour, delicately tuberculate, ellipsoidal, about 44 μ long and 23 μ broad.

Visitors.—Knuth observed 2 humble-bees, skg. (Bombus lapidarius *L.*, and B. pratorum *L.*): also Muscids, which did not go to the nectar, but crept about testing different parts of the flower, and occasionally transferred pollen.

2778. A. oleraceum L. (Schulz, 'Beiträge,' I, p. 98; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The flowers of this species are at first greenish-white in colour, but during anthesis they become dark-pink. Like those of the other species of the genus they are protandrous. They possess six stamens, the anthers of the inner ones dehiscing first; their filaments elongate a little, and the anthers project beyond the edge of the flower-bell; then those of the outer whorl mature in succession. At this time the style is still short and the stigmatic papillae still immature, the former only reaching its full length after 8–10 days, during which time the flowers remain uninterruptedly open (Warnstorf). The pollen-grains are white in colour, ellipsoidal, very delicately tuberculate, about 56 μ long and 25 μ broad.

2779. A. carinatum L. (Sprengel, 'Entd. Geh.,' pp. 183–6.)—Sprengel recognized this species as protandrous. He observed the honey-bee as a visitor.

2780. A. Schoenoprasum L., var. (*b*) **sibiricum** Willd. (Sprengel, op. cit., p. 185; Schulz, 'Beiträge,' I, p. 98; Axell, 'Om Anord. för Fanerog. Växt. Befrukt.,' p. 35; Ricca, Atti Soc. ital. sc. nat., Milano, xiv, 1871.)—The flowers of this species possess an odour of nectar, and are feebly protandrous in the Riesengebirge, automatic self-pollination being therefore possible, as they close at night.

Ricca found the variety (*c*) **alpinum** to be protandrous, and visited by numerous small Lepidoptera of the genus Crambus, even at an elevation of 2000 metres.

2781. A. Cepa L. (Sprengel, op. cit., p. 184; Herm. Müller, 'Fertlsn.,' p. 553; Kirchner, 'Flora v. Stuttgart,' p. 62; Knuth, 'Bloemenbiol. Bijdragen.')—The whitish flowers of this species are markedly protandrous; the thin inner anthers dehisce first, and then the outer ones, projecting straight out of the widely opened perianth. The style, at first only one mm. long, elongates to 5 mm. during dehiscence of the anthers, and the stigma only matures when these have withered.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth, the honey-bee, skg., and the hover-fly Eristalis tenax *L.*, po-dvg. Herm. Müller.—**A. Diptera.** *Empidae*: 1. Empis livida *L.* **B. Hymenoptera.** (*a*) *Apidae*: 2. Bombus terrester *L.* ♂; 3. Halictus cylindricus *F.* ♂; 4. Prosopis punctulatissima *Sm.* (*b*) *Sphegidae*: 5. Miscus campestris *Ltr.* All skg. Alfken (Bremen), 3 bees — 1. Prosopis brevicornis *Nyl.* ♀, rare; 2. P. communis *Nyl.* ♀ and ♂, very common; 3. P. pictipes *Nyl.* and P. punctulatissima *Sm.* F. F. Kohl (gardens in Bozen), 4 Chrysididids—1. Chrysis rutilans *Oliv.*; 2. C. distinguenda *Spin.*; 3. Parnopes grandior *Pall.*; 4. Ellampus spina *Lep.* (= E. productus *Dahlb.*), 7 wasps—1. Vespa rufa *L.*; 2. Eumenes pomiformis *F.* (Tyrol); 3. E. unguiculata *Vill.*; 4. Leionotus dantici *Rossi*; 5. L. bidentatus *Lep.*; 6. Epipona spiricornis *Spin.*; 7. Ancistrocerus parietum *L.*

2782. A. fistulosum L. (Sprengel, op. cit., pp. 183–6.)—This species is also protandrous.

Visitors.—Sprengel observed the honey-bee.

891. Hyacinthus L.

Bee flowers with juicy tissue at the base of the ovary, or with concealed nectar secreted there.

2783. H. orientalis L. (Sprengel, 'Entd. Geh.,' p. 200; Herm. Müller, 'Fertlsn.,' p. 554, 'Weit. Beob.,' I, p. 278; Knuth, 'Bloemenbiol. Bijdragen'; Warnstorf, Schr. natw. Ver., Wernigerode, xi, 1896.)—Sprengel states that in this species the ovary possesses three whitish spots on its upper side, each secreting a small drop of nectar. Warnstorf also says that nectar is secreted in three large spherical drops on the upper part of the ovary, in three furrows alternating with the sutural grooves of the carpels. Hermann Müller, however, could find no free secretion of nectar, but he describes the base of the perianth as juicy, and therefore probably bored by long-tongued visitors. The perianth tube is 12–15 mm. long. Its lower third surrounds the ovary with its short style and three-lobed stigma. It is slightly contracted above this, and its middle third bears the anthers, which mature simultaneously with the stigma. An insect probing at the base of the flower touches the anthers with one side of its proboscis and the stigma with the other, thus favouring cross-pollination. Automatic self-pollination is prevented by the usually horizontal position of the flower, and can in any case only take place in flowers which are by chance vertical. The pollen-grains are ellipsoidal, sulphur-yellow in colour, very finely papillose, on an average 75 μ long and 25 μ broad.

Visitors.—Hermann Müller (H. M.), Buddeberg (Budd.), and Knuth (Kn.) observed the following.—

A. Coleoptera. *Nitidulidae*: 1. Meligethes, in great numbers, apparently po-dvg. (H. M.). **B. Diptera**. *Syrphidae*: 2. Cheilosia sp., vainly searching for nectar (H. M.); 3. Eristalis sp., po-cltg. (H. M.). **C. Hymenoptera**. *Apidae*: 4. Andrena albicans *Müll.* ♂ (Budd.); 5. A. fulva *Schr.* ♀, skg.; 6. Anthophora pilipes *F.* ♀ and ♂, freq., skg. (H. M., Budd.); 7. Apis mellifica *L.* ☿ (Kn., H. M.); 8. Bombus hortorum *L.* ♀ (Kn.), one, skg.; 9. B. terrester *L.* ♀, skg. (H. M.); 10. Halictus albipes *F.* ♀, po-cltg. (Budd.); 11. Osmia cornuta *Ltr.* ♂, skg. (Budd.); 12. O. rufa *L.* ♀ and ♂, very common, skg. (H. M.). **D. Lepidoptera**. 13. Rhodocera rhamni *L.*, freq., 1 skg. (H. M.); 14. Vanessa io *L.*, skg. (H. M.); 15. V. urticae *L.*, not infreq., skg. (Kn.).

The following were recorded by the observers, and for the localities stated.—

Alfken (Bremen), 5 bees—1. Andrena albicans *Müll.* ♂; 2. Bombus pratorum *L.* ♀; 3. B. terrester *L.* ♀; 4. Osmia rufa *L.* ♀ and ♂; 5. Podalirius acervorum *L.* ♂. Friese (Mecklenburg), 3 bees—1. Melecta armata *Pz.*; 2. Osmia rufa *L.*, freq.; 3. Podalirius acervorum *L.*, do. Schletterer and von Dalla Torre (Tyrol), the bee Melecta luctuosa *Scop.* ♂. Burkill (Yorkshire coast), 2 bees (Apis mellifica *L.*, skg., and Bombus terrester *L.*, do.) and the butterfly Vanessa urticae *L.*, skg. ('Fertlsn. of Spring Fls.'). Loew (Berlin Botanic Garden), 3 bees—1. Andrena fulva *Schr.* ♂, skg.; 2. Apis mellifica *L.* ☿, skg. or (?) boring for sap; 3. Osmia rufa *L.* ♂, do.

2784. H. amethystinus L. (MacLeod, 'Pyreneënbl.,' pp. 45–7.)—The blue, slightly overhanging flowers of this species are protandrous. The perianth tube is about 9–11 mm. long, the lobes about 2·5 mm. In the first stage of anthesis the anthers of the three longer stamens dehisce; they project 2·5 mm. beyond the stigma, so that in consequence of the pendulous position of the flowers, automatic self-pollination is excluded. In the second stage, the anthers of the three shorter stamens have dehisced, and are now situated at the same level as the maturing stigma by means of the elongation of the style, so that automatic self-pollination must take place. Secretion of free nectar has not been observed.

Visitors.—MacLeod observed 2 flies (Eristalis sp., and Bombylius sp.) and a lepidopterid (Aurora sp.).

892. Galtonia Decne.

2785. G. candicans Decne. (=Hyacinthus candicans *Baker*). (Knuth, 'Bloemenbiol. Bijdragen.')—This South African species is found with us as a garden plant with markedly protandrous flowers. At first the pollen-covered anthers bend together towards the centre. After they have dropped off the filaments bend back towards the perianth. The style, which was previously surrounded by them, thus becomes free, and the terminal stigma develops its papillae; the latter are now in the position previously occupied by the anthers, so that crossing must be effected when insects of suitable size visit the flowers. These use the stamens as alighting-rods in the first stage and the style in the second. Nectar is abundantly secreted by the lower side of the ovary and stored in the base of the flower. Six nectar-passages about 8 mm. deep, are situated between the broadened roots of the filaments.

Visitors.—Knuth (Kiel Botanic Garden) observed the honey-bee and the humble-bee Bombus terrester ♀ and ☿, both skg. persistently.

893. Gloriosa.

2786. G. (Methonica) superba L. (Delpino, 'Sugli appar. d. fecondaz. nelle piante autocarp.,' pp. 23–4; Hildebrand, Bot. Ztg., Leipzig, xxv, 1867.)—In the downwardly directed flowers of this species the stamens and style diverge horizontally outwards and serve, Delpino supposes, as alighting-rods for insect visitors. Hildebrand supplements this by asserting that in younger flowers the style, and in older ones the stamens, serve this purpose, so that the former are dusted with pollen from the latter.

894. Muscari Tourn.

Bee flowers with juicy tissue at the base of the ovary and the perianth. Grassmann says that nectar is secreted by the septal glands of the ovary. At the tip of the inflorescence there are usually brightly-coloured, long-stalked flowers, which often remain closed like buds, and are asexual, serving only as an attraction.

2787. M. botryoides Mill. (= Hyacinthus botryoides *L.*). (Herm. Müller, 'Weit. Beob.,' I, pp. 277–8; Kirchner, 'Flora v. Stuttgart,' p. 65.)—In this species a number of bright blue flowers, directed obliquely upwards, and remaining closed with reduced reproductive organs, are found above the dark-blue ones with whitish teeth, which are pendulous to horizontal, and possess well-developed stamens and carpels. They serve to heighten the conspicuousness of the inflorescence. When the perfect flowers open, their anthers and stigma are mature. The almost spherical flowers have contracted small openings, and the anthers dehisce introrsely, so that visitors boring the juicy basal tissue touch some of them with one side of their bodies and the stigma with the other, thus as a rule effecting cross-pollination.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller, the honey-bee. Loew (Berlin Botanic Garden), the hover-fly Eristalis aeneus *Scop.*, settling on the outside of the corolla, and 2 bees—1. Andrena fulva *Schr.* ♀, skg.; 2. Apis mellifica *L.* ☿, boring for sap.

2788. M. comosum Mill. (=Hyacinthus comosus *L.*). (Knuth, 'Blütenbiol. Beob. a. d. Ins. Capri,' pp. 25–7; Schulz, 'Beiträge,' II, p. 170; Sprengel, 'Entd. Geh.,' p. 201.)—The plants belonging to this species that I examined in the island of Capri possessed an inflorescence which, during the bud stage, was only a few centimetres long, and was contracted into a spike; later, however, by elongation of the axis, a raceme of 20–30 cm. was developed. The upper 20–30 flowers remain sterile; they are deep-blue in colour, and develop upwardly directed stalks, 1–2 cm. in length, of the same colour. They are completely closed and asexual. Below them are some open flowers with reduced pistils and finally, below these, 30–40 blossoms with fully developed stamens and carpels. Schulz describes the colouring of the perianth (at Bozen) as pale greyish-yellow, marked with bright metallic brown towards the edge. The flowers examined by him possessed a perianth 7–12 mm. long and 4–12 mm. wide; those at Capri are 8 mm. long on an average. They are homogamous, the anthers being situated close under the stigma, so that automatic self-pollination takes place if insect-visits fail. Otherwise cross-pollination is favoured.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Schulz (S. Tyrol), Lepidoptera and long-tongued bees. Knuth (Capri, early April, '92), 2 bees—Anthophora femorata *Oliv.*, and A. pilipes *F.* ♀ and ♂. With extended bodies and loudly humming they flew very rapidly about in the mature flowers, usually only touching them for a moment with their forelegs (more rarely clinging to them), and probing them deeply with their long, widely extended proboscis, They did this with great rapidity, and as quickly hurried away to visit a distant plant of the same species. To catch some of these bees was a very tedious matter. Friese (Fiume), 2 bees—Andrena julliani *Schmiedekn.*, and A. tscheki *Mor.*

2789. M. tenuiflorum Tausch (= M. comosum *Mill.*, according to the *Index Kewensis*). (Schulz, op. cit., I, p. 99, II, p. 200.)—In this species the grey-greenish-brown flowers, with a touch of violet, are feebly protogynous. As the stigma is situated just beneath or between the anthers, automatic self-pollination is easily possible. There are also flowers with reduced pistils above those with complete stamens and carpels, and other apical, long-stalked, bud-like ones, completely closed, and serving only for attraction.

2790. M. racemosum Mill. (=Hyacinthus racemosus *L.*). (Herm. Müller, 'Weit. Beob.,' I, p. 278; Schulz, op. cit., II, pp. 168–70.)—The perianth in this species is about 6 mm. long and 3 mm. broad, and dark-violet in colour. The flowers are protogynous, the stigmas being mature before anthesis. The anthers are at first apposed to the perianth, and bend later towards the stigma, so that automatic self-pollination takes place. Insects searching for the sparingly secreted nectar at first effect cross-pollination more easily, touching stigma and anthers with opposite parts of their bodies. Above the normal flowers are partially reduced ones, and at the top 3–9 completely neuter open ones.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Thuringia), the honey-bee, freq., skg. or po-cltg., and the butterfly Vanessa urticae *L.*, occasionally skg. Schletterer (Pola), the bee Eucera longicornis *L.* Friese, Fiume (F.), Trieste (T.), and Hungary (H.), 8 bees—1. Andrena albofasciata *Ths.* (F.); 2. A. croatica *Friese*, freq. (F.); 3. A. julliani *Schmiedekn.* (F.); 4. Eucera caspica *Mor.*, very freq. (H.), var. perezi *Mocs.*, freq. (H.); 5. Halictus fasciatellus *Schenck* ♀ (H.); 6. H. obscuratus *Mor.*, not infreq. (F., H., T.); 7. Nomada fabriciana *L.*; 8. N. verna *Mocs.* (F., H.). Loew (Berlin Botanic Garden), 2 bees—Apis mellifica *L.* ☿, boring for sap, and Osmia rufa *L.* ♂, do.

2791. M. neglectum Guss.—

Visitors.—Loew (Berlin Botanic Garden) observed the bee Osmia rufa *L.* ♂, boring for sap.

2792. M. Lelievrii Bor. (=M. botryoides *Mill.*, according to the *Index Kewensis*).—

Visitors.—Loew (Berlin Botanic Garden) observed the bee Andrena fulva *Schr.* ♀, skg.

2793. M. pallens Bess.—

Visitors.—Loew (Berlin Botanic Garden) observed the honey-bee, boring for sap.

895. Hemerocallis L.

Flowers with infundibulo-campanulate, short-tubed perianth, storing nectar at its base, which is only accessible to long-tongued butterflies.

2794. H. fulva L. (Sprengel, 'Entd. Geh.,' pp. 43, 203; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 212, 218, 402; Maximowicz, Věst. obšč. sadov., St. Petersburg, Protok. 324, 1888.)—The red-yellow, fragrant flowers of this species bloom for one day only; Kerner says that they open between 6–7 a.m. and close between 8–9 p.m. They are protogynous for half an hour only. The mature stigma projects from the still closed perianth. When the latter opens about half an hour later, the anthers dehisce. The style projects considerably beyond them, however, as Baillon (Bull. soc. linn., Paris, 1881, pp. 295–6) points out, so that self-pollination is excluded, while insects probing for the nectar store at the base of the perianth first brush against the stigma and dust it with foreign pollen, and then dust themselves afresh. Kerner states that the nectar is only accessible to long-tongued butterflies, in spite of the shortness of the perianth tube (2 cm.), because the entrance is so contracted that only a thin, bristle-like proboscis can be inserted. Such visitors have not yet been observed in European gardens. According to Sprengel's assertion, which Kerner confirms, the plant never sets fruits here, so that it is highly probable that in its original home (East Asia) it is pollinated by such butterflies, which are not to be found in Europe. Maximowicz states that artificial pollination is also ineffective; the flowers do not produce mature seeds in Europe. Sprengel, who pollinated the flower artificially with its own pollen, also obtained no fruits.

2795. H. flava L. (Sprengel, op. cit., p. 202; Kerner, op. cit., II, p. 213.)—The flowers of this species, as of the preceding one, are laterally directed, yellow in colour, and odourless. They also possess the same mechanism; autogamy is therefore excluded. Anthesis lasts more than six days. The species is self-sterile, according to Focke.

2796. H. Dumortieri Morr., and **2797. H. serotina.**—Focke describes these species as self-sterile.

896. Funckia Spreng.

Kerner (op. cit., II, p. 304) states that in species of this genus the stigmas are at first concealed behind the stamens; later on the filaments bend backwards, so that the stigmas are freed.

897. Narthecium Moehr.

Homogamous pollen flowers. Filaments beset with hairs directed obliquely upwards.

2798. N. ossifragum Huds. (Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 142–3, 167; 'Weit. Beob. ü. Bl. u. Insekt. a. d. nordfr. Ins.,' p. 239.)—In the North Frisian islands the inflorescences of this species are spikes made up of 8–15 yellow flowers with red anthers. No nectar is secreted, but the flowers possess a fragrance resembling that of Habenaria bifolia. Soon after the flowers open anthers and

stigma mature simultaneously, but automatic self-pollination is excluded, for these organs do not come into contact, there being about 3 mm. distance between them. So long as I observed the honey-bee only as quite a casual visitor, I was of opinion that regular autogamy was probable as well as pollination, by means of the extremely violent wind prevailing in the islands. The filaments are 3–4 mm. long, and beset with very numerous dense yellow hairs, almost one mm. long and directed obliquely upwards, which not only increase the conspicuousness of the flowers, but also serve as hold-fasts for insects, and as weels for catching pollen. Sometimes this is temporarily deposited here when it has missed the stigma of the same flower until it is carried to it by a fresh gust of wind, when automatic self-pollination is effected, and sometimes the pollen is carried by the wind to a flower of an adjacent plant, when it is again caught first by the filament-hairs and transferred thence to the stigma when occasion offers, crossing thus being brought about. It may be seen that this latter occurrence is not exactly rare from the fact that numerous pollen-masses—sharply distinguished from the yellow filament-hairs by their yellow-red

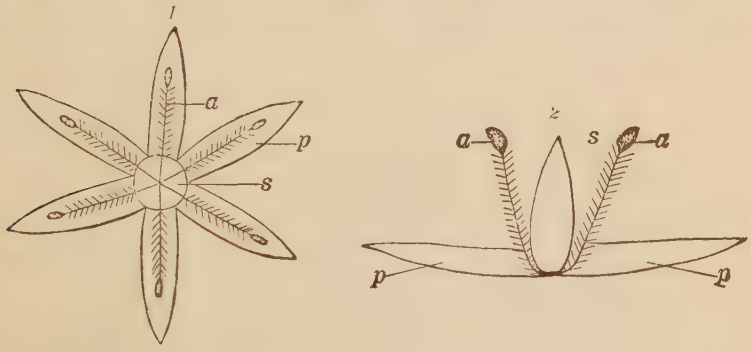


FIG. 401. *Narthecium ossifragum*, *Huds.* (from nature, diagrammatic). (1) Flower, seen from above. (2) Do., from the side, after removal of some stamens and part of the perianth (× 2½). *a*, anthers; *p*, perianth; *s*, stigma.

colour—are to be found not only on the inner sides of the stamens, but are also often found caught by the hairs on the outer sides of the filaments; this latter must therefore be foreign pollen. Having at a later date observed various bees and flies as busy and constant visitors of these flowers in the North Frisian Islands, I am now convinced that the anemophily just described must be considered only as an exception, and that pollen is as a rule transferred by insects. Kerner states that autogamy takes place towards the end of anthesis by fall of pollen.

Willis and Burkill's description ('Fls. and Insects in Gt. Britain,' I, p. 267) of the flower mechanism for Central Wales agrees with mine for the North Frisian Islands; they, however, frequently observed automatic self-pollination, the flowers opening so late that the anthers had already dehisced and had dusted the stigmas. The reason for this might have been that the plant was almost at the end of the flowering season. The tissue at the base of the filaments is, according to Willis and Burkill, juicy, and is perhaps bored by bees, if they visit the flowers.

VISITORS.—The following were recorded by the observers, and for the localities stated.—

Borgstette (Borg.), Tecklenburg (Herm. Müller, 'Weit. Beob.,' I, p. 274), and Knuth (Kn.) Föhr.—**A. Diptera.** *Muscidae*: 1. Cynomyia mortuorum *L.*, skg. (Borg.); 2. Lucilia caesar *L.* (Borg.); 3. Pyrellia cadaverina *L.* (Borg.). **B. Hymenoptera.** *Apidae*: 4. Apis mellifica *L.* ☿, po-cltg. (Borg., Kn.); 5. Colletes daviesanus *K.* ♀ (Kn.); 6. Halictus albipes *F.* ♀, po-cltg. (Borg.); 7. H. cylindricus *F.* ♀, (Kn.); 8. H. malachurus *K.* ♀, po-cltg. (Borg.); 9. H. rubicundus *Chr.* ♀, do. (Borg.). Willis and Burkill (Central Wales, 'Fls. and Insects in Gt. Britain,' I, p. 267.—**A. Diptera.** (*a*) *Muscidae*: 1. Anthomyia radicum *L.*, freq., po-dvg.; 2. Hydrellia griseola *Fall.*, do.; 3. Hylemyia lasciva *Zett.*, do. (*b*) *Syrphidae*: 4. Platycheirus manicatus *Mg.*, po-dvg. **B. Hemiptera.** 5. One sp., rare. **C. Hymenoptera.** (*a*) *Formicidae*: 6. Myrmica rubra *L.*, po-dvg. (*b*) *Ichneumonidae*: 7. One sp.

898. Asparagus Tourn.

Dioecious, rarely hermaphrodite flowers with concealed nectar stored at the base of the perianth.

2799. A. officinalis L. (Herm. Müller, 'Fertlsn.,' p. 548, 'Weit. Beob.,' I, pp. 282–3; Breitenbach, Bot. Ztg., Leipzig, xxxvi, 1878, pp. 163–7; Schulz,

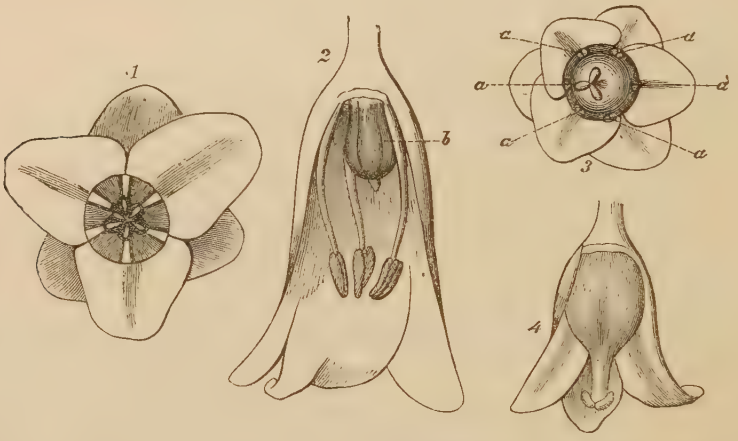


FIG. 402. *Asparagus officinalis*, *L.* (after Herm. Müller). (1) Male flower, from below. (2) Do., after removal of half the perianth; from the side. (3) Female flower, from below. (4) Do., after removal of half the perianth; from the side. *a*, vestigial stamens; *b*, vestigial ovary.

'Beiträge,' II, p. 199; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Kirchner, 'Flora v. Stuttgart,' p. 662; Knuth, 'Bloemenbiol. Bijdragen.')—The whitish-green, pendulous flower-bells of this species possess a characteristic odour. Most of the stocks are unisexual, but every flower possesses vestiges of the other sex. The male flowers, which are first visited by insects, are larger, and therefore more conspicuous, than the female ones; their perianth is 6 mm. long, that of the latter only 3 mm.

Breitenbach first pointed out that besides purely male and purely female stocks, hermaphrodite ones also occur, which, however, do not bear hermaphrodite flowers alone, but also other transition forms showing various degrees of reduction of the pistil. Breitenbach, however, observed no intermediate forms between female and hermaphrodite flowers, and thus no stocks which besides hermaphrodite flowers bore others possessing vestigial stamens devoid of pollen. Schulz states

that purely male and purely female, more rarely also purely hermaphrodite stocks, or hermaphrodite ones bearing either male or female flowers, occur in the same habitat. Warnstorf describes the pollen-grains as reddish-yellow in colour, ellipsoidal, almost smooth, about 37 μ long and 19–21 μ broad.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth, the honey-bee, freq., skg. and po-cltg. Herm. Müller, 5 bees—1. Apis mellifica *L.* ☿, very common, skg. and po-cltg.; 2. Halictus sexnotatus *K.* ♀, po-cltg.; 3. Megachile centuncularis *L.* ♀, skg.; 4. Osmia rufa *L.* ♀, skg.; 5. Prosopis dilatata *K.* ♀, skg. Plateau (Belgium), the bee Megachile ericetorum *Lep.* Friese (Hungary), the bee Andrena rufohispida *Dours.* Loew (Silesia, 'Beiträge,' p. 32), 3 bees—1. Apis mellifica *L.* ☿, skg.; 2. Halictus sexnotatus *K.* ♀, skg.; 3. Megachile octosignata *Nyl.* ♂, skg.; (Berlin Botanic Garden), the bee Halictus sexnotatus *K.* ♀, skg. von Fricken (Westphalia and East Prussia), and Redtenbacher (Vienna), 2 Chrysomelid beetles—Crioceris asparagi *L.*, very common, and C. duodecimpunctata *L.*, infreq.

2800. A. acutifolius L.—The flowers of this species are pale green in colour.

Visitors.—Plateau observed the bee Megachile ericetorum *Lep.*, and small hover-flies.

2801. A. scaber Brign. (=A. amarus *DC.*).—

Visitors.—As last species; also the honey-bee.

899. Ruscus L.

2802. R. aculeatus L.—Hildebrand (Ber. D. bot. Ges., Berlin, xxxviii, 1896) describes this species as monoecious.

900. Rohdea Roth.

2803. R. japonica Roth.—This species, which should perhaps be placed here, was observed by Delpino ('Ult. oss.,' pp. 239–40; Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870) to be visited and pollinated by snails (Helix aspersa *Müll.*, H. vermiculata *Müll.*, and others). They devoured the thick, fleshy perianth, and then crept on to another inflorescence. Fruits were only set in flowers visited by snails.

Baroni (Nuovo Giorn. bot. ital., Firenze, xxv, 1893) says that perhaps earthworms pollinate this species as well as snails and insects. Artificial pollination was effective.

901. Convallaria L.

Feebly protandrous pollen flowers, possessing juicy tissue at the base of the ovary[1]. Septal glands absent, according to Grassmann.

2804. C. majalis L. (Hildebrand, 'D. Geschlecht-Vert. b. d. Pfl.,' p. 62; Herm. Müller, 'Fertlsn.,' p. 549, 'Alpenblumen,' p. 54; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 109, 119, 200–1; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 310–11; Schulz, 'Beiträge,' II, pp. 167–8; Ludwig, D. bot. Monatsschr., Arnstadt, i, 1883, p. 106; Kirchner, 'Flora v. Stuttgart,' p. 70; Knuth, 'Bloemenbiol. Bijdragen'; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The flowers of this species are devoid of nectar[1], but possess a delightful fragrance. In the small,

[1] *Cf.* foot-note on Leucojum aestivum *L.*

pendulous bells the style projects up to 2 mm. beyond the anthers. Pollen-collecting bees therefore first touch the stigma and then the anthers, so that cross-pollination is ensured by insect-visits. Should these fail, automatic self-pollination takes place by the fall of pollen upon the papillose edge of the stigma.

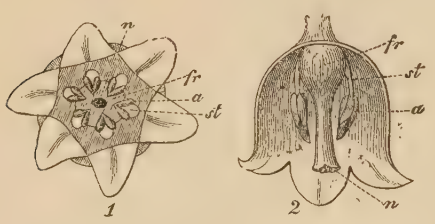


FIG. 403. *Convallaria majalis*, *L.* (after Herm. Müller). 1) Flower, seen directly from below. (2) Do., seen from the side after removal of half the perianth with three of the epipetalous stamens. *a*, anthers; *fr*, ovary; *n*, stigma; *st*, filaments.

Besides the usual form with bright yellow anthers and pure white perianth, Ludwig observed another in Thuringia with vivid yellow anthers and certain parts of the flower coloured red, such as the base of the perianth, hypogynous disk, or the base of the filaments. Ludwig states that this large-flowered form secretes free nectar on the disk situated below the ovary, so that it appears to be entomophilous to a greater degree than the ordinary one. Schulz, however, says that this is not the case, as in both forms the flowers are of the same size, and the hypogynous disk is provided with sugary juice without secretion of free nectar.

VISITORS.—Knuth observed the honey-bee, freq., po-cltg. Herm. Müller records the honey-bee, and also (in the Alps) the Cerambycid beetle Acmaeops collaris *L.*

902. Polygonatum Adans.

Homogamous humble-bee or bee flowers, white in colour, with a greenish tip. Nectar secreted, usually in large quantities, by the septal glands of the ovary, and stored at the base of the perianth.

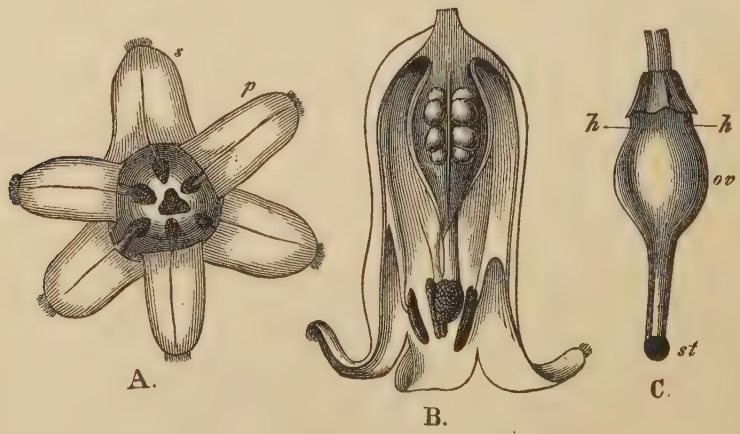


FIG. 404. *Polygonatum verticillatum*, *All.* (after Herm. Müller). *A*. Flower, seen directly from below (× 7). *B*. Do., in longitudinal section. *C*. Pistil. *h*, nectar; *ov*, ovary; *p*, petals: *s*, sepals; *st*, stigma.

2805. P. verticillatum All. (= Convallaria verticillata *L.*). (Herm. Müller, 'Alpenblumen,' pp. 52–3; Schulz, 'Beiträge,' II, pp. 166, 224; Grassmann,

'D. Septaldrüsen'; Kirchner, 'Flora v. Stuttgart,' p. 71.)—The flowers of this species are adapted for pollination by bees. The vertically pendulous flower-bells are 8–10 mm. long. They secrete abundant nectar at their base. Bees searching for this cling to the lower side of the flower, and touch the introrse anthers with one side of their bodies, and with the other the stigma, which matures simultaneously, and is situated at the same level as the anthers, thus effecting cross-pollination. Nectar-sucking lepidoptera do not necessarily touch both organs with their thin proboscis. Should bee-visitors fail, automatic self-pollination takes place in consequence of the proximity of anthers and stigma.

Visitors.—Herm. Müller (Alps) observed 2 humble-bees and 2 Lepidoptera. Schulz noticed numerous Hymenoptera and small Lepidoptera: also perforated flowers.

2806. P. officinale All. (= Convallaria Polygonatum *L.*). (Sprengel, 'Entd. Geh.,' p. 198; Herm. Müller, op. cit., pp. 53–4; Grassmann, op. cit.; Almqvist, Bot. Centralbl., Cassel, xxxviii, 1889, p. 663; Kirchner, op. cit., p. 70.)—The flowers of this species are adapted for pollination by humble-bees. They possess an odour of bitter almonds, and conceal the nectar[1] in the base of the perianth bell (14–17 mm. long), so that it is only accessible to the longest-tongued bees. The flower entrance is almost filled up by the stigma. As the anthers are situated about 3 mm. above the latter, it is touched by humble-bee visitors before the pollen, crossing being thus brought about. Should humble-bee visits fail, automatic self-pollination is effected by fall of pollen. Almqvist found no free nectar in flowers examined by him at Stockholm, but the walls of the ovary and perianth contained sweet juice, which could only be extracted by boring[1].

In the Alps the perianth tube is often perforated, and the nectar stolen, by Bombus mastrucatus. The hole made by this humble-bee is then used by other insects also to steal nectar. I have never observed perforation in flowers in North Germany.

Visitors.—Loew (Berlin Botanic Garden) observed the humble-bee Bombus lapidarius *L.* ☿, skg.

2807. P. latifolium Desf. (= Convallaria latifolia *Jacq.*). (K. F. Jordan, 'D. Stellung d. Honigbehälter.')—In this species the entrance to the flower is situated between the introrse anthers and the stigma, so that suitable visitors must chiefly effect crossing.

2808. P. multiflorum All. (= Convallaria multiflora *L.*). (Herm. Müller, 'Fertlsn.,' p. 550, 'Weit. Beob.,' I, p. 283; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v., 1893, pp. 311–13; Grassmann, 'D. Septaldrüsen'; Kirchner, 'Flora v. Stuttgart,' p. 71; Almqvist, Bot. Centralbl., Cassel, xxxviii, 1889, p. 663; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896; Knuth, Bloemenbiol. Bijdragen.')—The flowers of this species are adapted for pollination by humble-bees. The perianth tube is 11–18 mm. long, and its base, which secretes a little nectar, is only accessible to long-tongued bees, especially as the entrance to the flower is closed by the stigma and the anthers closely surrounding it, and the filaments are beset with hairs.

[1] *Cf.* the foot-note on Leucojum aestivum *L.*

Humble-bee visitors touch the stigma with one side of their bodies and some of the pollen-covered anthers with the other, thus regularly effecting cross-pollination. At the same time, however, they press the opposite side of the stigma against the anthers, and thus bring about self-pollination also. This takes place automatically when suitable visitors fail.

In this species Almqvist could find no free nectar, but only sugar-containing tissue.

Warnstorf could find no nectar in the flowers. He says that the stigmatic papillae are receptive while the flowers are still closed. The style varies in length; it may be short, or reach to about the middle of the perianth tube, or even attain the same level as the anthers. Stocks bearing hermaphrodite and male flowers are not rare. The pollen-grains are white in colour, ellipsoidal, smooth, on an average 65–70 μ long and 31 μ broad.

Geisenheyner (Ber. D. bot. Ges., Berlin, xiii, 1895) observed a tendency to the formation of male flowers at Kreuznach and other places.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (Lippstadt), the hover-fly Rhingia rostrata *L.*, very freq., po-dvg., and 3 bees—1. Andrena fasciata *Wesm.* ♀, skg. and po-cltg.; 2. Bombus agrorum *F.* ♀, skg.; 3. B. hortorum *L.*, do. MacLeod (Flanders), a humble-bee.

903. Maianthemum Wigg.

Protogynous flowers with little or no secretion of nectar at the base[1] of the flower. Ovary with septal glands (Grassmann).

2809. M. convallaria Wigg. (= M. bifolium *Schmidt*, and Convallaria bifolia *L.*). (Kirchner, 'Flora v. Stuttgart,' p. 69; MacLeod, Bot. Jaarb. Dodonaea Ghent, v, 1893, pp. 313–14; Schulz, 'Beiträge,' II, p. 168.)—In the small, white, fragrant flowers of this species the perianth lobes and stamens at first diverge widely; the anthers are still closed, but the stigma already receptive. The perianth lobes then bend backwards again and the anthers of the stamens directed obliquely upwards dehisce introrsely. When insects visit the flowers, cross-pollination is favoured by the distance between stigma and anthers. Should insect-visits fail, pollen can easily fall upon the still receptive stigma, in consequence of the almost vertical position of the flower. Automatic self-pollination is thus easily possible. Warnstorf describes the pollen-grains as white in colour, ellipsoidal, almost smooth, up to 50 μ long and 19 μ broad.

Visitors.—Schulz observed small flies.

904. Streptopus Michx.

Homogamous or feebly protogynous bee flowers, secreting nectar at the base of the perianth leaves.

2810. S. distortus Michx. (= S. amplexifolius *DC.*, and Uvularia amplexifolia *L.*). (Warming, Bot. Tids., Kjöbenhavn, xvi, 1886, pp. 39–40; Schulz, 'Beiträge,' I, pp. 98–9, II, p. 224.)—In this species the whitish, pendulous flowers are sprinkled or blotched with red on the inside and on the edges of the sepals which

[1] *Cf.* the foot-note on Leucojum aestivum *L.*

project beyond and enclose the petals. There are six stamens, the three outer possessing two lateral teeth above the base. In species examined by Schulz, in the Riesengebirge, the anthers mature at the same time as the stigma, but Warming describes those in Greenland as feebly protogynous. In a later stage of anthesis the stigma projects a little beyond the anthers. Self-pollination by fall of pollen is easily possible in consequence of the position of the flower. Access to the nectar can only be obtained through three narrow canals, which indicates humble-bee pollinators, although the normal visitors have not yet been observed.

905. Paris L.

Markedly protogynous pollen flowers, which Hermann Müller describes as deceptive.

2811. P. quadrifolia L. (Herm. Müller, 'Fertlsn.,' p. 557, 'Weit. Beob.,' I, p. 283; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 87, 341; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 314; Kirchner, 'Flora v. Stuttgart,' p. 72.)—Flowers of this species perhaps belong to class **Fd** (*cf.* Vol. I, p. 135). They are devoid of nectar and fragrance, and the stigmas are mature when the flowers open; the yellow anthers do not dehisce until some days later, but the stigmas still remain receptive. In the first stage of anthesis the inconspicuous flowers offer no nutriment to insect visitors, but carrion-flies are attracted to them by the sometimes shining, but generally dull, dark-purple ovary and stigma, which deceptively suggest the presence of putrefying flesh. Later they produce powdery pollen, which floats away in a small cloud when the stamens are lightly struck. As the stigmas are still receptive, self-pollination can also take place; Kerner says that this is effected by contact of anthers and stigma.

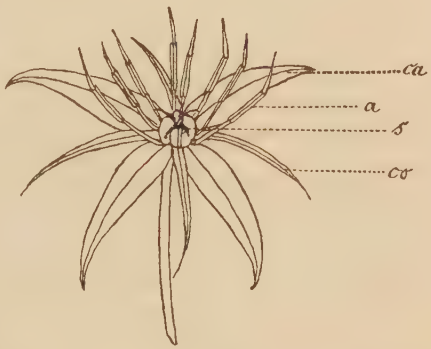


FIG. 405. *Paris quadrifolia*, *L.* (from nature). Flower, natural size, in its first (female) stage: the stigmas (*s*) are already mature, the anthers (*a*) still closed. *ca*, sepals; *co*, petals.

Female flowers sometimes occur with stamens devoid of anthers; these then resemble the petals in form and colour.

Warnstorf describes the pollen-grains as yellow in colour, irregular, roundish to ellipsoidal, finely tuberculate, about 40–50 μ long and 35 μ broad.

VISITORS.—These are rare. I have watched the plant under favourable conditions, and never seen any. Herm. Müller observed flies (including Scatophaga merdaria *F.*), and Kirchner a moth.

906. Trillium L.

Kerner ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 311) describes all the species of this genus as protogynous, so that cross-pollination is favoured at first. In T. grandiflorum *Salisb.* (op. cit.), two anthers are situated in each of the three angles formed

by the diverging stigmas, and in every dehisced anther only the pollen of the lobe turned inwards is devoted to autogamy, while that of the lobe facing outwards may be removed by insects after autogamy has been effected.

2812. T. erectum L.—Loew ('Blütenbiol. Beiträge,' II, pp. 78–9) describes this species as bearing nauseous flowers.

2813. T. grandiflorum Salisb.—The flowers of this species possess no unpleasant odour.

2814. T. sessile L.—

Visitors.—Loew (Berlin Botanic Garden) observed the beetle Cetonia aurata *L.*, dvg. the stamens in the base of the flower.

907. Kniphofia Moench.

2815. K. aloides Moench (= Tritoma Uvaria *Ker-Gawl.*).—Stadler ('Beiträge zur Kentniss d. Nektarien,' pp. 1–5) describes this species as first protogynous and then homogamous.

Visitors.—Errera and Gevaert (Bull. Soc. roy. bot., Bruxelles, xvii, 1878) states that these are butterflies.

908. Aphyllanthes Tourn.

2816. A. monspeliensis L.—Kerner ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 341) says that in this species the anthers do not at first touch the stigma, because the stamens diverge. Later on, however, these bend inwards, so that the anthers of the three shorter ones come into contact with the three lower stigmatic lobes and those of the three longer ones with the three upper lobes, autogamy being thus effected.

909. Veltheimia Gled.

2817. V. viridiflora Jacq. Bailey (Bull. Torrey Bot. Cl., New York, xiii, 1886, p. 62) describes this series as protandrous.

910. Camassia Lindl.

2818. C. Fraseri Torr.—Loew ('Blütenbiol. Beiträge,' pp. 236–7) has described the flower mechanism of this species.

Visitors.—Loew (Berlin Botanic Garden) observed the following.—

The Telephorid beetle Cantharis fusca *L.*, settling in the flowers, and 2 bees—1. Apis mellifica *L.* ☿, po-cltg. and boring for sap at the base of the ovary; 2. Osmia fulviventris *Pz.* ♂, boring for sap.

911. Albuca L.

2819. A. corymbosa Batt.—Wilson (Bot. Jaarb. Dodonaea, Ghent, iii, 1891) states that in flowers of this species humble-bees press the petals outwards, force their thorax between the inner anthers and the stigma, and effect cross-pollination. Autogamy is excluded. It was proved by experiment that the pollen of the inner anthers produced the best results.

2820. A. fastigiata Dryand.—(Wilson, op. cit.)—In this species autogamy is excluded. Artificial self-pollination is ineffective.

912. Aspidistra Ker-Gawl.

2821. A. elatior Blume.—Delpino regards this species as micromyophilous (*cf.* Vol. I, p. 15), but J. Wilson (Bibl. No. 3662) is of opinion that snails effect pollination; these slip through small openings in the flowers and usually bring about autogamy.

913. Colchicum L.

Protogynous flowers with concealed nectar, secreted by the thickened outer sides of the proximal ends of the free part of the filaments, and stored in furrows, 3–5 mm. long and covered with woolly hairs, at the bases of the perianth leaves.

2822. C. autumnale L. (Sprengel, 'Entd. Geh.,' pp. 206–8; Herm. Müller, 'Fertilisation,' p. 556; Kirchner, 'Flora v. Stuttgart,' p. 67; Schulz, 'Beiträge,' I, pp. 99–100; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 374; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 307–8; Knuth, 'Blütenbiol. Herbstbeob.,' 'Blütenbiol. Notizen'; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—In the large, bright-violet flowers of this species the stigmas are usually mature before the stamens, but remain receptive until the latter are ripe. If insects visit the flowers early, therefore, cross-pollination is ensured; if later, self-pollination is also possible, although rendered more difficult by the fact that the anthers turn their pollen-covered surfaces outwards and the stigmas often project later beyond the stamens, which were at first of the same length. Automatic self-pollination is possible when the flower closes or when the stigmas and anthers are at the same level.

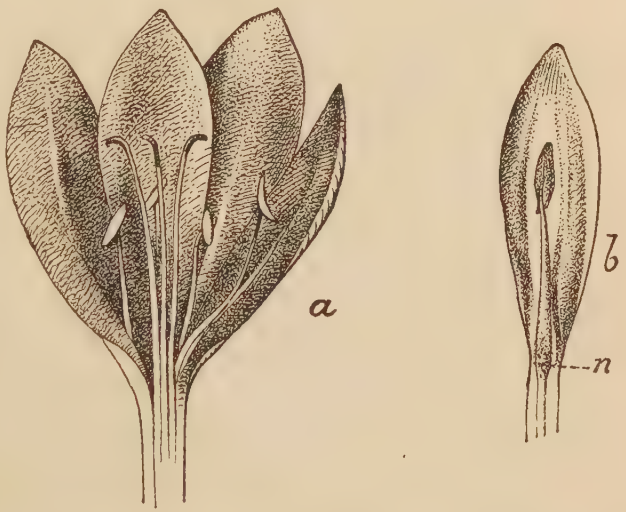


FIG. 406. *Colchicum autumnale*, L. (from nature). *a*, Flower (natural size) after removal of a sepal and a petal with their attached stamens: the three stigmas project beyond the anthers. *b*, A petal (natural size), with its stamen, and the thickened, nectar-secreting part (*n*) of the filament: behind is seen the nectar-storing furrow of the petal.

In these flowers, which open and close periodically, being open from about 9 a.m. until 6 p.m., homogamy or even protandry have been observed as well as protogyny. Kerner also observed heterostyly, and distinguished between flowers with long, medium, and short styles. The perianth leaves elongate later to such an extent that in long-styled flowers the three longer perianth lobes increase by

9 mm., and the three shorter by 12·6 mm. In the medium-styled forms the corresponding elongations are respectively 13·5 and 18·5 mm., and in the short-styled ones 10 and 15 mm. In the last form automatic self-pollination takes place towards the end of anthesis, not only by means of the pollen which has fallen on the inner side of the perianth lobes, but also by immediate contact of the stigma with the tips of the pollen-covered anthers.

Warnstorf also found the style in the flowers of the same bulb sometimes as long as, and sometimes longer than, the stamens, with a short apical, violet stigma, slightly bent downwards. The anthers were easily movable on conical, stiff filaments, and dehisced laterally. The pollen-grains were golden-yellow in colour, oily, clinging, irregularly tetrahedral, tuberculate, up to 43 μ in diameter.

The flowers are generally bilaterally symmetrical, one perianth leaf being longer and broader than the others, with the shortest one placed opposite to it.

Visitors.—The following were recorded as stated.—

Herm. Müller observed the humble-bee Bombus hortorum *L.* ♂, skg. In doing so it brushed against the stigmas with one side of its body and the anthers with the other, thus effecting cross-pollination. Knuth observed the honey-bee in particular. It was not content with searching for nectar in open flowers, but forced its way through the narrow entrances of flowers just opening, and dusted their already mature stigmas, having come completely covered with pollen from flowers with dehisced anthers. I also saw Musca domestica *L.*, skg. (?), and numerous minute muscids 1½ mm. long, as well as two butterflies (Vanessa io *L.* and V. urticae *L.*) creeping about the flower. On 9.9.'97 Knuth observed numerous po-dvg. hover-flies (Eristalis tenax *L.*; Syritta pipiens *L.*; Syrphus arcuatus *Fall.*; S. corollae *L.*; S. pyrastri *L.*). The Lepidoptera and flies did not touch the stigmas regularly in alighting, but generally flew straight to the anthers of the perianth lobes; this occasional touching of the stigma was enough, however, to pollinate all, for I found the stigmas of all open flowers thickly covered with pollen-grains. Self-pollination is also frequently brought about by the small muscids mentioned: it could not take place automatically in the flowers I observed, on account of the great projection of the stigmas beyond the anthers. Knuth also noticed a slug, Limax cinerea (?) (*cf.* Vol. I, p. 79, foot-note).

914. Uvularia L.

Kerner describes all the species of this genus as protogynous.

2823. U. grandiflora Sm.—This species agrees exactly with Trillium grandiflorum *Salisb.* (p. 470).

2824. U. perfoliata L. (=U. flava *Sm.*).—

Visitors.—Loew (Berlin Botanic Garden) observed the small bee Halictus cylindricus *F.* ♀, po-cltg.

915. Tricyrtis Wall.

2825. T. pilosa Wall. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 351.)—Self-pollination is at first excluded in this species by protogyny, and by the distance between stigma and anthers, and only cross-pollination by means of insects possible. Autogamy can take place later by the bending down of the style.

916. **Merendera** Ram.

Homogamous flowers with concealed nectar, secreted near the base of the outer side of the epiphyllous filaments, and collected at the bottom of a cleft situated on every perianth leaf.

2826. Merendera Bulbocodium Ram. (MacLeod, Bot. Jaarb. Dodonaea, Ghent, iii, 1891, pp. 298–301.)—The flowers of this species are pale-pink in colour, with very long claws to the perianth leaves; the relative position of anthers and stigmas changes. At first the stigmas are situated above the extrorse anthers, so that automatic self-pollination is excluded. The anthers are then raised to the level of the stigma by subsequent elongation of the perianth leaves, and at the same time turn somewhat inwards, enabling autogamy to take place.

Visitors.—MacLeod (Pyrenees) observed 2 humble-bees, a lepidopterid, and a fly.

917. **Veratrum** L.

Protandrous flowers with exposed nectar, which is much sought by flies (muscids). It is secreted by the thickened bases of the perianth leaves. Sometimes andromonoecism to androdioecism.

2827. V. album L. (Herm. Müller, 'Alpenblumen,' pp. 41–3; Schulz, 'Beiträge'; Knuth, 'Bloemenbiol. Bijdragen.')—The flowers of this species are of a dull dirty-yellow colour. In the Alps protandrous hermaphrodite flowers occur. There are six stamens, the anthers of the three outer first and then those of the three inner ones dehiscing outwardly and downwardly, so that the heads and backs of nectar-seeking insects are dusted with pollen. The stamens then become vertical, and the three styles bend their mature stigmas outwards and downwards, so that the pollen-covered visitors must brush against and dust them.

Besides the hermaphrodite flowers, andromonoeciously and androdioeciously distributed male ones occur. Schulz says that the variety (b) *lobelianum* Bern. possesses the same flower mechanism as the main type in the Alps, but it is sometimes homogamous also. Automatic self-pollination then takes place in consequence of the vertical position of the flowers.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller, 4 beetles, 13 Muscids, an ant, an ichneumonid, and 5 Lepidoptera; but no bees nor hover-flies. Knuth (Kiel Botanic Garden), the Muscid Musca corvina *F.* Schletterer and von Dalla Torre (Tyrol), the humble-bee Bombus hortorum *L.*

2828. V. nigrum L.—

Visitors.—Plateau (Ghent Botanic Garden) saw 3 Muscids—1. Musca domestica *L.*; 2. Lucilia caesar *L.*; 3. Calliphora vomitoria *L.*

918. **Tofieldia** Huds.

Protogynous or homogamous yellowish flowers, with half-concealed nectar secreted at the bases of the three furrows between the carpels.

2829. T. calyculata Wahlenb. (Herm. Müller, 'Alpenblumen,' pp. 39–40; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 334.)—In the yellowish flowers of this species the stigmas mature before the anthers, so that cross-pollination is brought about if insects visit them at the proper time. Should such visits fail, automatic self-pollination takes place as a last resort by the fall of pollen on the still receptive stigmas.

FIG. 407. *Veratrum album*, *L.* (after Herm. Müller). *A*. Hermaphrodite flower in the first (male) stage, after removal of half the perianth (× 3½). *B*. Reproductive organs of *A*, seen from above. *C*. Do., in longitudinal section. *D*. Reproductive organs of a flower in the second (female) stage (× 7). *E*. Male flower, seen directly from above (× 3). *F*. Do., in longitudinal section (× 7). *a* and *d*, anthers; *fi*, filaments; *n*, nectaries; *ov*, ovules; *pe*, petals; *st*, stigmas.

VISITORS.—Herm. Müller (Alps) observed three beetles, 6 flies, a bee, an ant, and 3 Lepidoptera.

2830. T. palustris Huds. (=T. borealis *Wahlenb.*). (Herm. Müller, op. cit., p. 40; Kerner, loc. cit.)—The flowers of this species are smaller than those of the preceding one, and therefore receive fewer visits, although they secrete nectar in the angles between all six stamens and the ovary. Hermann Müller states that they

are homogamous, and not protogynous, so that automatic self-pollination is possible from the beginning of anthesis. Kerner, however, describes the flowers as protogynous. If insects visit them, cross-pollination is favoured, as the visitor generally brushes against a stigma with one side of its body and the anthers with the other. Fresh specimens observed by Vanhöffen in Greenland bore white flowers (*cf.* Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' p. 79).

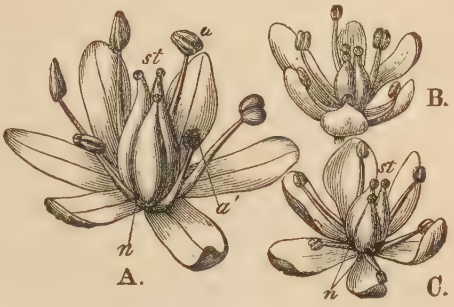


FIG. 408. *Tofieldia calyculata*, *Wahlenb.*, and *T. palustris*, *Huds.* (after Herm. Müller). *A*. Flower of *T. calyculata*. *B*. Do. of *T. palustris*, towards evening. *C*. Do., in the morning (× 7). *a* and *a'*, closed and dehisced anthers; *n*, nectary; *st*, stigma.

VISITORS.—Herm. Müller (Alps) observed 2 Muscids and a small lepidopterid.

2831. T. coccinea Rich. (Abromeit, op. cit., pp. 79–80.)—This species has denser inflorescences than the last one, and the flowers are typically of a purple-red colour.

919. Zygadenus Michx.

2832. Z. elegans Pursh.—The flowers of this species are dirty-white in colour, with green blotches.

VISITORS.—Plateau observed ants, other small Hymenoptera, and hover-flies.

CXV. ORDER *PONTEDERIACEAE* BENTH. ET HOOK.

920. Monochoria Presl.

Kuhn (Bot. Ztg., Leipzig, xxv, 1867) states that some species of this genus bear cleistogamous flowers.

921. Pontederia L.

Fritz Müller describes species of this genus as trimorphous (Jenaische Zs. Natw., vi, 1871, pp. 74–8).

922. Heteranthera Ruiz et Pav.

2833. H. reniformis Ruiz et Pav. (Herm. Müller, Kosmos, Leipzig, vii, 1880; Hildebrand, Ber. D. bot. Ges., Berlin, i, 1883.)—Herm. Müller says that this species possesses two kinds of stamens, one long one with pale-blue anthers, and two short ones with yellow pollen. When the small white flower opens, the former bends to the left, and the style to the right. Should insect-visits fail, self-pollination takes place. Hildebrand confirms the latter statement.

2834. H. zosteraefolia Mart. (Hildebrand, Jahrb. f. Syst., vi, 1885.)—In this species automatic self-pollination is at first excluded, but can take place later when

the flower closes. The anther of the long stamen is yellow, like those of the shorter ones.

2835. H. Kotschyana Fenzl (=H. callaefolia *Reichb.*).—Kirk states that this species possess cleistogamous flowers. Solms-Laubach also found these in several other species of Pontederiaceae, some indigenous to America and some to Africa.

CXVI. ORDER *COMMELINACEAE* BENTH. ET HOOK.

923. Commelina Plum.

Literature.—Herm. Müller, Kosmos, Leipzig, i, 1883, pp. 241–59; Breitenbach, op. cit, iii, 1885, p. 40 et seq. *Cf.* on division of labour of the stamens in this genus and Tinnantia, Vol. I, p. 108.

2836. C. benghalensis L.—Weinmann (Bot. Ztg., Leipzig, xxi, 1863) says that this species possesses subterranean cleistogamous flowers.

2837. C. tuberosa L. (MacLeod, Bot. Jaarb. Dodonaea, Ghent, ii, 1890, pp. 118–47.)—This species, and others of the genus (C. Karawinskii (?), C. communis (?)), are fertile at Ghent.

Visitors.—MacLeod observed 3 bees (1. Apis; 2. Bombus agrorum *F.*; 3. Halictus sp.), 2 hover-flies (Syritta sp., and Eristalis tenax *L.*), and the butterfly Pieris napi *L.*

2838. C. coelestis Willd.—Kerner ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 357) says that in the ephemeral flowers of this species autogamy finally takes place by the rolling up of the filaments and styles.

924. Tradescantia Rupp.

Kerner ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 171) states that when the flowers of species belonging to this genus fade their petals become pulpy, i.e. their surface is covered with a thin layer of liquid by the exuding of cell-sap from the tissue, which flies seek and lick off; in doing so they dust the stigma with foreign pollen.

2839. T. crassula Link et Otto, and **2840. T. virginiana** L.—Kerner (op. cit., p. 308) describes these species as protandrous.

CXVII. ORDER *JUNCACEAE* BARTL.

This order has been so thoroughly examined and described by F. Buchenau in his memoirs 'Monographia Juncacearum' (Bot. Jahrb., Leipzig, xii, 1890, pp. 1–495), and 'Ü. d. Bestäubungsverh. b. d. Juncaceen' (Jahrb. wiss. Bot., Leipzig, xxiv, 1892, pp. 363–424), that I follow him entirely in my statements, which form an abstract from these works, supplemented by some additions from Hermann Müller and O. Kirchner.

The Juncaceae bear anemophilous flowers. Self-pollination is usually prevented and cross-pollination made possible by protogyny (in some South American genera,

Distichia, Oxychloë, Patosia, by dicliny or dioecism). Homogamy seldom occurs. Schulz ('Beiträge,' II, p. 171) describes Juncus squarrosus *L.* as homogamous—'as the anthers of the three stamens dehisce immediately after the opening of the flower.' Kirchner ('Neue Beob.,' p. 10), however, says that the species is feebly protogynous. He states that Juncus arcticus *Willd.* is decidedly homogamous (at Zermatt), but with such short filaments that the tips of the anthers do not reach the stigma, self-pollination being thus prevented.

In protogynous species, the length of the first (female) stage of anthesis varies greatly; according to Buchenau ('Bestäubungsverh.,' p. 367) from a few hours (Juncus tenuis *Willd.*) up to several days (species of Luzula flowering in spring). After this female stage there is generally a hermaphrodite one, though in some species (Luzula campestris *DC.*, L. spadicea *DC.*), the stigmas have long been withered when the anthers dehisce, so that first a neuter and then a male stage follow the female one. A period sometimes follows closely on the hermaphrodite stage during which the stigmas are still receptive when the pollen has all been scattered and—in chasmogamous flowers—the perianth has closed. Then, if a part of the stigma is shut in, automatic self-pollination may take place by means of the pollen remaining on the perianth leaves.

Cleistogamy sometimes occurs. F. von Müller states that the Australian species Juncus homolocaulis *F. Muell.*, and perhaps also the North American species J. setaceus *Rostk.* and J. repens *Michx.*, seem to flower entirely cleistogamously. Cleistogamous flowers may also be found in Juncus bufonius *L.* (frequently), J. Chamissonis *Knuth*, J. capitatus *Weigel*, J. capillaceus *Lam.*, Luzula purpurea *Link* (occasionally), and probably in other species.

In cleistogamous flowers, the style and stigmas must be but short. As a rule the three inner stamens also disappear—Buchenau ('Bestäubungsverh.,' p. 371) states that the importance of their absence lies in the fact that the opening of the perianth depends upon the turgescence of the floral receptacle, including the bases of the stamens, so that when the inner ones are absent, this turgescence is lessened.

An extremely curious thing in many species is the intermittent flowering. Buchenau ('Monographia,' p. 41) states that during anthesis a large number (one-fifth up to even one-third) of the flowers are found open on one day, then, in spite of favourable weather, not a single open one for 10, 12, 14, or even 21 days, then again a large number open on one day, and so on. No connexion between this mode of flowering and the weather can be traced. It does possess oecological importance, however, for it greatly assists crossing by the numbers of flowers open at the same time (Buchenau, 'Bestäubungsverh.,' p. 369). This may also explain the fact that this method of flowering does not occur in species with crowded inflorescences, such as most of those belonging to Luzula, while it is seen most plainly in species of Juncus bearing single flowers, and in those with few-flowered capitula.

Buchenau ('Monographia,' p. 41) describes the course of anthesis in large inflorescences, and also inside the single capitula, as ascending; but the terminal spikelet or the terminal capitulum is mature before the lateral ones. Also where the flowers are solitary the terminal one is mature before the associated lateral ones.

The length of anthesis is (Buchenau, 'Bestäubungsverh.,' p. 370) very variable,

sometimes being only a few hours (Juncus tenuis *Willd.*, J. filiformis *L.*, J. Chamissonis *Kunth*, J. balticus *Willd.*), generally one day, but may extend over nine days or perhaps more (Luzula campestris *DC.*).

Each flower opens only once. Buchenau ('Monographia,' p. 41, 'Bestäubungsverh.,' p. 372) says that the opening depends on a usually very temporary turgescence of the floral receptacle, the bases of the filaments, and the inner surface of the perianth leaves, the swelling being shared very unequally by these organs in different species.

All species of Juncaceae do not bear inconspicuous flowers, for a large number possess brilliantly coloured ones. Buchenau enumerates 41 such species ('Bestäubungsverh.,' pp. 373–4), and these are therefore probably entomophilous, as they form abundant masses of pollen and are well adapted to attract insects by the brightly-coloured, shining, juicy cells at the base of the flower (pseudo-nectaries).

Luzula lutea *DC.* and L. nivea *DC.* are almost the only ones of our Central European species possessing a brightly coloured perianth, and they are visited by insects. In Graubünden Hermann Müller ('Alpenblumen,' pp. 38–9) saw the former visited by a po-cltg. humble-bee and a po-dvg. hover-fly; a hawk-moth (Zygaena) rested idly on the flowers. At Chur he frequently saw Luzula nivea *DC.* visited by a flower-beetle (anthobium).

Buchenau ('Bestäubungsverh.,' pp. 378–9) gives the following account of the flower mechanisms actually occurring among Juncaceae.—

I. Autogamy.—Fertilization of the flower with its own pollen certainly takes place very frequently and effectively.

(a) *Cleistogamous Flowers*, usually also cryptantherous.—Apparent exclusively in Juncus homalocaulis *F. Muell.*, perhaps also in J. repens *Michx.* and J. setaceus *Rostk.*; associated with chasmogamy in J. bufonius *L.*, J. capitatus *Weigel*, J. pygmaeus *Rich.*(?), J. Chamissonis *Kunth*, J. capillaceus *Lam.*, Luzula purpurea *Link*, and probably other species also.

(b) *Chasmogamous Flowers.*

(1) Those with stigmas and anthers very near together (flowers often opening but little): Juncus tenuis *Willd.*, J. Chamissonis *Kunth*, J. pygmaeus *Rich.*, J. triglumis *L.*, Luzula purpurea *Link*, Prionium Palmita *E. Mey.*

(2) Those in which the stigmas are still receptive when the perianth closes, and then come into contact with the pollen-grains of the same flower strewn on the perianth leaves: species of Luzula.

(3) Those with stigmas and anthers not very near each other, in which during the hermaphrodite stage pollen reaches the stigma of the same flower when the anthers dehisce, or by means of the wind or of being shaken: numerous species.

II. Geitonogamy, more rarely **Xenogamy.**—These can, of course, only occur in chasmogamous flowers, and are greatly assisted by protogyny (more or less marked). Geitonogamy is necessary in the case of Luzula campestris *DC.* (and L. spadicea *DC.* (?)), where in consequence of complete heterogamy the flowers are first female, then neuter, and finally male.

(a) *Anemophily.*—Pollen is transferred to the stigmas of adjacent flowers by means of the wind or mechanical shaking acting in the same way; this certainly

occurs frequently, and is indicated by the transparent stigmatic papillae, which are as a rule of unusual length and generally associated with smooth, powdery pollen.

(b) The stigma of one flower projects into the cavity of an adjacent one and there comes into contact with the anthers; this occurs frequently in Luzula.

(c) The pollen rolls down into the glabrous hollow tubes formed by the perianth lobes, and so reaches the stigmas of flowers situated at a lower level: Luzula nivea *DC.*, L. albida *DC.*, and certainly other species.

(d) *Entomophily.*—Insects are attracted by the considerable size and vivid colouring of the flowers, and also by the abundant pollen and the shining turgescent tissue; these convey the pollen to other flowers of the same or another plant of the same species: numerous Alpine species of Juncus, especially from the Himalayas: Luzula nivea *DC.*, L. lactea *E. Mey.*, L. elegans *H. B. et K.*, and others.

III. Dioecism.—Xenogamy is necessary: Patosia, Oxychloë, Distichia.

Vanhöffen (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' pp. 80–5) observed the following species flowering in Greenland during June and August.—Juncus biglumis *L.*, J. triglumis *L.*, J. castaneus *Sm.*, J. arcticus *Willd.*, Luzula confusa *Lindeb.*, L. hyperborea *R. Br.* (= L. arctica *Blytt*), and L. spicata *DC.*

Andersson and Hesselman ('Bidrag till Känned. om Spetsbergens v. Beeren Eil. Kärlväxtflora,' pp. 82–3) made observations on the times of flowering and fruiting of the following species in Spitzbergen.—Luzula Wahlenbergii *Rupr.*, L. arcuata *Summ.*, L. arcuata var. *hyperborea R. Br.*, L. nivalis *Beurl.*, Juncus biglumis *L.*, J. triglumis *L.*, and J. castaneus *Sm.*

925. Juncus L.

2841. J. acutiflorus Ehrh.—Anthesis, no doubt, lasts but one day in this species, which is markedly protogynous, being usually female in the morning and hermaphrodite after midday. It probably flowers in a distinctly intermittent manner. The stigmas are bright purple-red or rose-red in colour, with long, transparent papillae.

2842. J. alpinus Vill., var. **genuinus** Buchen.—In this species the female stage usually lasts two days. In the following hermaphrodite one the flowers open early in the morning or before midday, and close after midday or in the evening. The male stage then begins, and lasts two or even three days.

2843. J. anceps Laharpe, var. **atricapillus** Buchen.—The flowering of this species is distinctly intermittent. Anthesis usually lasts less than 24 hours, and sometimes scarcely 12. The stigmas are greenish, with very long transparent papillae.

2844. J. arcticus Willd.—Intermittent flowering is marked in this species. The female stage begins in the early part of the day, and lasts 2–3 hours; then the perianth opens, and the anthers dehisce shortly afterwards. Towards evening the flowers close again completely, so that anthesis is ended in one day, and, on account of the fewness of blossoms, flowering does not take place for more than two or, at the most, three days. The stigmas are pale pink with transparent papillae.

2845. J. atratus Krocker.—Flowering is distinctly intermittent in this species. Anthesis lasts 30–2 hours, the female stage occupying about 25. The stigmas are pale purple-red with transparent papillae.

2846. J. balticus Willd.—This species flowers intermittently in a very marked way. Open flowers can only be found on a few days. Anthesis lasts one day.

2847. J. bufonius L.—(Batalin, Bot. Ztg., Leipzig, xxix, 1871, pp. 388–92; Ascherson, op. cit., pp. 551–5; Haussknecht, op. cit., pp. 802–7.)—Batalin states that in Russia this species possesses only three stamens and always fertilizes itself cleistogamously. At Halle a. S. Ascherson observed hexandrous, open, lateral flowers as well as triandrous, cleistogamous, terminal ones. The occurrence of chasmogamous flowers was to some extent confirmed by Haussknecht, who found hybrids between this species and J. sphaerocarpus *Nees*, which is also chasmogamous. Buchenau says that more flowers open in bright weather than when it is dull and damp. Between the star-shaped open hexandrous flowers and the closed (cleistogamous) usually triandrous ones there are transition forms, many flowers opening slightly, but fertilizing themselves cryptantherously, while others remain closed, but their anthers dehisce and phaenantherous self-fertilization takes place. In the chasmogamous flowers (which do not always open intermittently) the stigmas remain in the perianth. This opens between 5–6 a. m., after a female stage lasting about two hours the hermaphrodite one begins; towards midday the flowers are closed again. Automatic self-pollination is then possible, the closing perianth leaves depositing the pollen lying on their inner surface upon the stigma. The pollen is white or pale pink in colour, with very long transparent papillae.

2848. J. capillaceus Lam.—This South American species possesses triandrous, cleistogamous flowers, in addition to the hexandrous, chasmogamous ones.

2849. J. capitatus Weigel.—This species is partly cleistogamous with quite a short style, and partly chasmogamous with a style half as long as the ovary. In the chasmogamous flowers anthesis lasts one day. There are also transition forms. These imperfectly cleistogamous flowers open a little, so that one can see the tips of the stigmas from above. When the anthers dehisce, their pollen falls upon the stigmas. These are yellowish-white in colour, with transparent papillae.

2850. J. castaneus Sm.—The flowers of this species only open like a funnel, and their anthesis lasts from 2–3 days: on the first morning the stigmas project, and on the second the anthers dehisce.

2851. J. Chamissonis Kunth.—The flowers of this species are more or less cleistogamous, but phaenantherous. All the stages are over in one morning. In the most widely opened flowers the tips of the perianth leaves diverge so far that the upper halves of the stigmatic branches become visible, so that although cross-pollination is not impossible it is extremely improbable.

2852. J. compressus Jacq., and **2853. J. Gerardi** Loisel.—These species usually flower intermittently, but some flowers are always open on the intervening days. Anthesis lasts one day. The stigmas are purple-red in colour, with transparent papillae.

Warnstorf states that J. compressus possesses hermaphrodite flowers opening only in sunshine, and possessing very long stigmatic branches which are spirally twisted and persistent. The stamens are short, being only of the same length as the ovary, so that autogamy is excluded. The pollen-grains are tetrahedral, feebly tuberculate, on an average 27 μ in diameter.

2854. J. effusus L.—This species flowers with well marked intermittence. Anthesis lasts only a short time. The perianth opens before 5 a.m. and the stigmas diverge; about 7 a.m. the anthers dehisce, and at 3 p.m. most of the flowers have closed again, and the pollen-grains have sent out long tubes into the stigmatic tissue. Schulz ('Bestäubungseinricht.,' II) describes the flowers as homogamous. The stigmas are bright purple in colour, with widely projecting transparent papillae.

2855. J. fasciculatus Schousb.—In this species the ovary is drawn out into a long style, so that the stigmas protrude beyond the perianth when the flower opens.

2856. J. filiformis L. (Axell, 'Om Anord. för Fanerog. Växt. Befrukt.,' p. 38.)—Axell recognized and figured the protogyny of this species. Intermittence is less marked than in J. balticus *Willd.* and J. effusus *L.* Anthesis is of short duration. The female stage lasts from 5–6 or 6.30 a.m.; towards midday the perianth leaves are again firmly closed. Schulz describes the flowers as homogamous. The stigmas are pale-red in colour, with transparent papillae.

2857. J. Fontanesii J. Gay.—There is no intermittence in this species. The flowers open early in the morning, the female stage lasting until 10 a.m. The anthers dehisce between 10 and 12. In the evening the perianth closes, but the projecting stigmas remain receptive a day longer. In cool, damp weather the flowers remain open for two days, and the female stage then lasts 24 hours.

2858. J. glaucus Sibth.—Intermittence is very marked in this species. The course of anthesis resembles that of J. effusus *L.*, but the flowers remain open longer. In damp, cool weather cleistogamy also undoubtedly occurs. The stigmas are of a beautiful purple-red colour, with transparent papillae projecting on all sides.

2859. J. homalocaulis F. Muell.—Plants of this species raised from seeds sent by Ferdinand Müller to Buchenau were strictly cleistogamous and cryptantherous. Buchenau never observed the perianth lobes open until they were pressed apart by the ripening of the fruits. The stigmas are white in colour.

2860. J. Jacquini L.—Intermittence is very marked in this species. Anthesis lasts one day. The stigmas are dark and pale purple-red in colour, though the long papillae cause them to appear rose-red.

2861. J. lampocarpus Ehrh.—This species flowers partly intermittently and partly normally. The female stage usually lasts only from early morning until midday. In the evening the flowers close again, but the stigmas still project and remain receptive until the next day. Schulz pointed out ('Beiträge,' II, p. 171) this marked protogyny, and concludes from it that autogamy is probably rare, but cross-pollination by means of the wind frequent. The stigmas are whitish or pale-red in colour, with long transparent papillae.

2862. J. lomatophyllus Spreng.—Intermittence is extremely marked in this species. Anthesis lasts three days. A short female stage follows the hermaphrodite one of the second day. The stigmas are purple-red in colour, with widely projecting transparent papillae.

2863. J. maritimus Lam.—No intermittence can be observed in this species. Anthesis last about 36 hours. The female stage lasts the whole day. The stigmas are of a beautiful purple-red colour, with velvety papillae.

Visitors.—Scott-Elliot (Dumfriesshire) observed a wasp ('Flora of Dumfriesshire,' p. 175).

2864. J. obtusiflorus Ehrh.—The plants of this species flower with marked intermittence, there being intervals of three to four days when no flowers open. Anthesis lasts one day; the female stage two to four hours. The stigmas are white in colour with a faint reddish tinge. The papillae are moderately long.

2865. J. pelocarpus E. Mey.—Buchenau examined herbarium specimens of this North American species; it possesses numerous flowers opened in the shape of a star, so that the plant probably blooms distinctly intermittently. Before the perianth opens the elongated stigmas project from the closed flower.

2866. J. punctorius L.—The anthesis of this species resembles that of J. obtusiflorus *Ehrh.* Distinct intermittence has not been observed. The stigmas are like those of J. obtusiflorus.

2867. J. pygmaeus Rich.—The flowers of this species open between 6–7 a.m. and close again at midday; the anthers dehisce about 9 a.m. The fully opened flower is tulip-shaped. When the perianth closes the stamens and stigmas are pressed so closely together that the flowers appear to be cleistogamous, but real cleistogamy occurs. The stigmas are bright purple in colour, with long, projecting papillae.

2868. J. repens Michx.—This species is indigenous to Cuba and the southern United States of North America. Buchenau examined herbarium specimens. It seems to be cleistogamous.

2869. J. setaceus Rostk.—This species is indigenous to the south-eastern United States and seems (from herbarium specimens) to be always cleistogamous.

2870. J. squarrosus L.—This species flowers distinctly intermittently. Anthesis lasts less than 12 hours. Early in the morning the open flower is female, the anthers dehisce after 8 a.m., and the blossom closes again soon after midday. The stigmas are brick-red in colour, with long, transparent papillae. Schulz ('Beiträge,' I, p. 102) states that in the Riesengebirge the flowers are homogamous or very feebly protogynous. The stigma often only matures completely after the opening of the perianth. It is generally receptive until after the dehiscence of the anthers. In dull weather the flowers do not seem to open much, and many then fade pseudo-cleistogamously.

2871. J. striatus Schousb.—There is no intermittence in this species. The stigmas project from the closed flowers. This female stage lasts one day. The hermaphrodite one in the opened flower is over in less than 12 hours. On the third day the flower opens again and is once more female, and on the

fourth day it fades. The stigmas are pale-purple in colour, with long papillae.

2872. J. supinus Moench.—In this species intermittence is obvious. The stigmas do not project from the perianth lobes. Anthesis lasts $\frac{1}{2}$–$1\frac{1}{2}$ days, and the female stage for about 2 hours. The stigmas are pale-red in colour, with very long transparent papillae.

2873. J. Tenageia Ehrh.—No distinct intermittence can be observed in this species. The stigmas do not project from the perianth. Anthesis lasts one day, the female stage three or more hours. Cleistogamy probably occurs sometimes, but phaenantherously. The stigmas are pale yellowish-white in colour with transparent papillae.

2874. J. tenuis Willd.—This species flowers distinctly intermittently. Anthesis is extremely brief (from about 7–8 a.m. until 12 noon). The female stage lasts one hour. The stigmas do not project from the perianth.

2875. J. trifidius L.—This species is markedly protogynous, with a female stage lasting two days; the hermaphrodite one is probably of the same length. The stigmas are greenish-white in colour, with long closely-set papillae.

2876. J. valvatus Link.—This Portuguese species does not flower intermittently, but continuously. The blossoms only open into the form of a funnel, and are female the first day, hermaphrodite the second, and then female again with a closed perianth for one or several days longer. The stigmas are white in colour with transparent papillae.

2877. J. triglumis L.—Kerner (*teste* Buchenau, 'Monographia,' pp. 398–9) describes this species as protogynous. Allogamy is possible in the first stage; in the second (hermaphrodite) one autogamy takes place by contact of the stigmas and anthers.

926. Luzula DC.

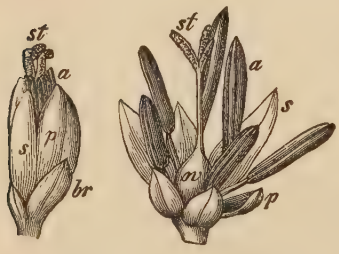
2878. L. campestris DC., var. *vulgaris* Gaud.—There is no intermittence in this species. Anthesis begins with the projection of the long, greenish-white stigmas from the tip of the still-closed perianth. This female stage lasts one or several days. Before the flower opens the stigmas almost always fade completely, and a neuter stage, lasting several (4–7) days, follows, so that the perianth does not open until 5–9 days after the projection of the stigmas. On the following (the 6th to the 9th) day the anthers dehisce, and the pollen is scattered about when the flowers are shaken. The perianth is therefore open fully 36 hours, and usually closes during the night following the 6th–9th day. Meehan (Proc. Acad. Nat. Sci., Philadelphia (Pa.), 1868, p. 156) has already described the chief points, which are also accurately given by Schulz ('Beiträge,' I, p. 102).

2879. L. nigricans Desv. (=L. campestris *DC.*, var. *sudetica* DC.). (Schulz, 'Beiträge,' I, p. 103.)—Schulz describes this species as less protogynous; most of the stigmas fade only a little at the tip before the flower opens, but many remain quite receptive. The anthers dehisce immediately after the flowers open, and as their tips are at the same level as those of the perianth leaves, automatic self-pollination no doubt almost always takes place.

2880. L. Hostii Desv. (=L. flavescens *Gaud.*).—There is no intermittence in this markedly protogynous species. The tips of the yellow-green stigmas, beset with transparent papillae, project from the perianth while it is still firmly closed. This female stage lasts 3–4 days, the perianth then opens in the form of a star and the flower is hermaphrodite for some hours.

2881. L. Forsteri DC.—There is no intermittence in this species. After a purely female stage lasting 4–5 days, the perianth opens for some hours; the anthers then dehisce, and finally, after 5–6 hours, the flower closes again. The stigmas are white, pale-yellowish or greenish in colour. Schulz ('Beiträge,' II, p. 171) states that in North Italy the flowers show all stages from marked to feeble protogyny.

2882. L. glabrata Desv.—No intermittence can be observed in this species. The flowers are first female with closed perianth for 1–3 days. Then the perianth opens for 24 hours at the most. When it closes again the papillae of the white stigmas shrivel.



A. B.

FIG. 409. *Luzula lutea*, *DC.* (after Herm. Müller). *A*. Flower just opening. *B*. Do., open (× 7). *a*, anthers; *br*, bract; *ov*, ovary; *p*, petals; *s*, sepals; *st*, stigmas.

2883. L. lutea DC.—The pale golden-yellow flowers of this Alpine species are female 1–2 days, the perianth then opening and a hermaphrodite stage of 2–4 days' length following. After 3–4 days the pale greenish-white stigmas, beset with short velvety papillae, are no longer receptive, so that the flowers are ultimately purely male.

During the hermaphrodite stage there is ample opportunity for autogamy or geitonogamy, the pollen being shaken about in clouds, and rolling down to flowers situated lower, or reaching the stigmas of adjacent flowers by direct contact of the anthers.

Hermann Müller ('Alpenblumen,' pp. 38–9), however, states that protogyny scarcely exists; the stigmas are not completely mature when the flower begins to open, and are only receptive when it is entirely so. The anthers dehisce soon after, so that automatic self-pollination is easily possible. The flowers then close again, and the stigmas shrivel. The smooth, loose pollen-grains are easily carried away by wind, but they also cling to insects' bodies, so that pollen can sometimes also be transferred by this means. Hermann Müller, as already stated, actually observed some visitors.

2884. L. albida DC. (=L. nemorosa *E. Mey.*, and L. angustifolia *Winder*).—Buchenau found this species (and also the variety *rubella* Hoppe in the Riesengebirge) to be markedly protogynous. The female stage lasts one or two, perhaps sometimes even three days. The flowers then open in one or two hours, and the following hermaphrodite stage regularly lasts two days. On the third morning the stigmatic papillae are shrivelled. Autogamy is therefore possible, but geitonogamy more probable. It is also possible that the white inflorescences attract insects.

Schulz ('Beiträge,' I, p. 102) gives a very different description. He says that

protogyny is very feeble, and that the flowers open very soon, after the short stigmas have projected a very little from the flower. The anthers dehisce soon after. In many cases the flowers do not open very widely, and as the anthers do not project beyond the perianth leaves, the pollen can only be removed from the flower by a very strong wind.

Schulz observed the variety *rubella* to be often completely homogamous in the Riesengebirge, the stigmas maturing only when the flowers opened, and the anthers dehiscing soon afterwards. The stigmas are white in colour, with short velvety papillae.

2885. L. nivea DC.—The female stage in this species lasts 1–3 days, the ensuing hermaphrodite one 1–4 days, and a male stage sometimes follows. The stigma is like that of the preceding species. Autogamy is possible, but geitonogamy by contact of the stigmas of one flower with the anthers of an adjacent one is undoubtedly more frequent. Kerner also asserts that pollen-grains can easily roll down the smooth, hollow inner side of the perianth leaves and reach the stigmas of flowers situated at a lower level. The snow-white perianth leaves also occasionally attract visitors, so that pollen may be transferred by this means.

Visitors.—Hermann Müller ('Alpenblumen,' p. 39), as already mentioned, frequently observed a small flower-beetle in the blossoms.

2886. L. pedemontana L.—The stigmas of flowers belonging to this species resemble those of L. albida *DC.*

2887. L. vernalis DC. (= L. pilosa *Willd.*). (Hildebrand, 'D. Geschlechts-Vert. b. d. Pfl.,' p. 18; Warnstorf, Schr. natw. Ver., Wernigerode, xi, 1896.)—Hildebrand mentioned the protogyny of this plant. Buchenau says that the female stage lasts several (up to 7) days; the ensuing hermaphrodite one ends on the day on which the anthers dehisce. The stigmas are greenish-white in colour, with long transparent papillae. Warnstorf states that the three stigmatic branches project considerably beyond the anthers before the flower opens, and are beset with long papillae. As the branches of the inflorescence are for the most part bent downwards when the anthers dehisce, autogamy can easily take place. The pollen-grains are whitish in colour, tetrahedral, smooth, about 37 μ in diameter.

2888. L. purpurea Link.—This species flowers continuously. Some of the blossoms are entirely cleistogamous but phaenantherous. The chasmogamous flowers open early in the morning, and are then female for a short time; the ensuing hermaphrodite stage is also brief. The flowers are firmly closed at 3 p.m. The stigmas are pale-green in colour, with very long transparent papillae.

2889. L. rufescens Fisch.—Judging from herbarium material of this species, anthesis takes a similar course to that of L. vernalis *DC.* and L. Hostii *Desv.*

2890. L. maxima DC. (= L. sylvatica *Gaud.*).—This markedly protogynous species does not flower intermittently. The stigmas project widely and completely from the still-closed perianth. This female stage lasts one or two days. The flowers then open and the anthers dehisce. When the perianth now closes the stigmas are still quite or partially receptive, so that a second female stage seems to follow the hermaphrodite one. The stigmas are pale-green in colour, with short transparent papillae.

2891. L. spadicea DC.—Schulz ('Beiträge,' II, p. 171) and Buchenau state that plants of this species growing in the open air pass through a rather long female stage which, however, ends when the perianth opens, so that after a short neutral interval a male stage follows. In plants cultivated by Buchenau, on the contrary, the hermaphrodite stage followed the female one without any interval. The stigma is greenish-white in colour, with rather short, but not velvety papillae.

927. Distichia Nees et Meyen.

2892. D. muscoides Nees et Meyen; **2893. D. filamentosa** Buchen.; and **2894. D. tolimensis** Benth. et Hook. These Andean species, which grow near the snow-line, are dioecious. The female flowers are very inconspicuous. The male flowers of the first two species are unknown, those of the last possess a perianth of dark-brown colour, and open into the form of a funnel.

2895. D. Philippi.—This species, native to the desert of Atacama, is dioecious; the female flowers possess short stalks and the male longer ones; both forms appear to open into the form of a funnel.

928. Patosia Buchen.

The dioecious plants of species belonging to this genus are indigenous to the cordilleras of Chili. The female flowers are completely concealed in the axils of the foliage-leaves, the stigmas projecting at the end of a very long style. The male flowers possess slender stalks.

929. Prionium E. Mey.

2896. P. Palmita E. Mey.—This Cape shrub bears hermaphrodite flowers, which open into the form of a shallow bowl.

930. Rostkovia Desv.

2897. R. sphaerocarpa Desv. (= R. magellanica *Hook. f.*).—This species is indigenous to Tierra del Fuego, and bears large hermaphrodite flowers which open apparently in the form of a star.

2898. R. grandiflora Hook. f. (= Marsippospermum grandiflorum *Hook.*), and **2899. R. gracilis** Hook. f. (= M. gracile *Buchen.*).—The very large flowers of these antarctic species open into the form of a funnel, and are apparently protogynous.

CXVIII. ORDER *PALMAE* BARTL.

931. Sabal Adans.

2900. S. Adansoni Guerns.—Delpino ('Altri appar. dicog. recent. oss.,' p. 61) describes this species as entomophilous. He saw the nectar-bearing, protogynous flowers, with a milk-white perianth, visited and pollinated by Hymenoptera (Halictus sp., and Polistes gallica *L.*).

932. Chamaedorea Willd.

Species of this genus (Delpino, op. cit.) are also entomophilous.

933. Cocos L., and 934. Syagrus Mart.

Species of these genera are anemophilous (Delpino, op. cit.).

935. Phoenix L.

2901. P. dactylifera L.—This species is anemophilous. The ancient Assyrians probably understood artificial pollination of the female flowers by pollen from the male cones. (E. B. Tylor, 'Fertlsn. of the Date-Palm in Ancient Assyria'; C. Sterne, Prometheus, II, pp. 675–8.)

936. Chamaerops L.

2902. C. humilis L.—This species is anemophilous. In the year 1751, Gleditsch (Hist. Acad., Berlin, (1749) 1750, pp. 103–8) described an experiment on the artificial pollination of the Palma dactylifera folio flabelliformi, by which we understand this palm. Gleditsch says (Sachs, 'History of Botany,' p. 393), '"Our palm in Berlin is a female, and may be 80 years old; the gardener asserts it has never borne fruit, and I have myself never seen fertile seeds on it during fifteen years." As there was no male tree of the kind in Berlin, Gleditsch procured some pollen from the garden of Caspar Bose in Leipsic. In the course of the nine days' journey, the greater part of the pollen escaped from the anthers, and Gleditsch feared that it was spoilt; but he was re-assured by the Leipsic botanist Ludwig, who had had experience in Algiers and Tunis, that the Africans usually employ dry pollen that has been kept for some time for the purpose of fertilisation. Though the flowering of the female tree was nearly over, he strewed the loose pollen on its flowers, and tied the withered inflorescence of the male plant to a late blowing shoot of the female. The result was that fruit ripened in the following winter, and germinated in the spring of 1750. A second attempt conducted in a similar manner produced an equally favourable result.'

CXIX. ORDER *TYPHACEAE* JUSS.

Literature.—Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 139; Engler and Prantl, 'Typhaceae,' in 'D. nat. Pflanzenfam.,' II, 1, p. 185.

Monoecious wind flowers, arranged in capitate or cylindrical spikes. The male flowers, which are situated above, mature later than the female ones below. Engler and Prantl describe Typha and Sparganium as protandrous.

937. Typha L.

Monoecious protogynous wind-flowers, arranged in cylindrical spikes.

2903. T. latifolia L. (Knuth, loc. cit.; Kronfeld, Bot. Centralbl., Cassel, xxxix, 1889, p. 21.)—The male flowers of this species do not dehisce until the stigmas have shrivelled, and still contain pollen when the female flowers have set fruits. Kronfeld observes that this species tends to produce unisexual plants, and that Dietz observed a purely male specimen in the Pesth Botanic Garden. Warnstorf describes the sulphur-yellow pollen-masses as being up to 50 μ in diameter,

and composed usually of four, more rarely of two or three roundish, opaque grains.

2904. T. angustifolia L. (Knuth, loc. cit.)—The flower mechanism of this species is the same as that of the preceding one. Unisexual plants have not yet been observed.

2905. T. minima Hoffm. (= T. Laximanni *Lepech.*). (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 313.)—Kerner says that the interval between the maturation of the female and male flowers in this species is about nine days.

938. Sparganium L.

Protogynous, monoecious wind flowers, arranged in globular spikes. Warnstorf describes the pollen-grains as of the same size and shape in all the species, yellowish in colour, rounded, tetrahedral, with a network of tubercles, on an average 20 μ in diameter.

2906. S. ramosum Curt. (=S. erectum *L.*). (Kirchner, 'Flora v. Stuttgart,' p. 83; Knuth, loc. cit.)—The globular female spikes in this species are situated below the male ones and mature before them; the stigma begins to shrivel when the anthers of the small male spikes dehisce. The anthers are one mm. long and are adnate to movable filaments about 3 mm. long. Each male spike possesses some hundred stamens, and each female one 100–150 stigmas. Pollination is easily effected by the wind, because the stigmatic branches are 3 mm. long, situated on a style 2 mm. high, and therefore project widely. The diameter of the female spike is thus increased to $1\frac{1}{2}$ cm.; that of the male one is only about half as much.

2907. S. simplex Huds. (W. J. Behrens, Flora, Marburg, New Ser., xxxvii, 1879; Knuth, loc. cit.)—The flower mechanism in this species is the same as that of the preceding one, but the male and female spikes are smaller, and composed of fewer flowers.

CXX. ORDER *AROIDEAE* JUSS.

Literature.—Engler and Prantl, 'Araceae,' in 'D. nat. Pflanzenfam.,' II, 3, pp. 108–9; Knuth, 'Grundriss d. Blütenbiol.,' p. 94.

The hermaphrodite or unisexual flowers are closely crowded on a fleshy axis, and form a spadix generally surrounded by a spathe. Insects are attracted partly by this, partly by the inflorescence, and partly by a coloured, club-shaped elongation of the spadix, or by several of these simultaneously.

939. Arum L.

Monoecious, protogynous, pitfall flowers.

2908. A. maculatum L. (Delpino, 'Ult. oss.,' pp. 17–21; Hildebrand, Bot. Ztg., Leipzig, xxviii, 1870, pp. 589, 591; Herm. Müller, 'Fertlsn.,' p. 562; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 292–3; Kirchner, 'Flora v. Stuttgart,' p. 86; Christy and Corder, 'Arum maculatum'; Knuth, 'Bloemenbiol. Bijdragen.')—In this species the upper part of the spathe, together with the thick, dark-red end of

the spadix projecting from it, serve to attract minute midges, particularly those of the genus Psychoda. The decomposing, urinous smell of the inflorescence during anthesis is a further attraction. The ventricose lower part of the spathe forms a temporary prison for the small visitors. As they creep downwards on the projecting, red-brown end of the spadix, they reach several rows of stiff bristles situated close above one another at the top of the contraction in the spathe, which stretch from the narrowed spadix to the inner surface of the spathe. The midges creep through them in order to reach the warmth and the red-brown colouring of the inner surface of the spathe, which from this point widens into a pit. They cannot at once escape from this. The threads would not hinder their creeping back through them, but the insects try to fly out, and fail to escape by this means, as they are only struck back by the fence of bristles when they fly towards the bright upper part of the pit.

The small prisoners find the mature stigmas in the first stage of anthesis, and deposit foreign pollen upon them in the attempt to gain the open once more. The stigmas then shrivel up, and in the place of each appears a minute drop of nectar, as compensation to the insects for their delay and their work of pollination. The anthers now dehisce and let their pollen escape, so that it fills the base of the pit, and the small visitors are dusted with it. Meanwhile the bristles barring the entrance have become limp, and the spathe opened out, and the visitors can now leave their temporary prison without difficulty. I have often observed that on cutting open a spathe the midges immediately fly to another plant and again creep down into the trap. On leaving the flower, therefore, they will go to another, and dust the stigmas with the foreign pollen.[1]

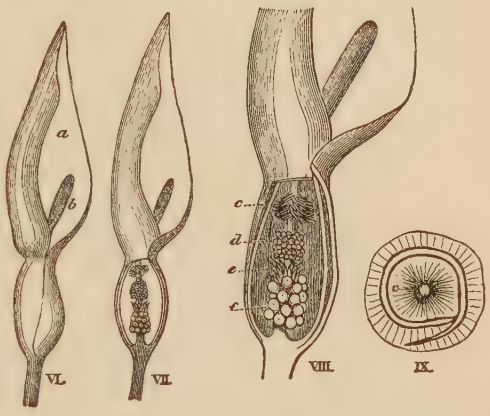


FIG. 410. *Arum maculatum*, *L.* (after Herm. Müller). VI. External view of inflorescence. VII. Do., with the trap cut open (×¾). VIII. Do. (almost natural size). IX. Transverse section just above the trap-hairs. *a*, Upper part of spathe; *b*, dark-purple tip of the spadix, serving as an attraction and conducting-rod; *c*, trap-hairs (vestigial stamens); *d*, still immature male flowers (anthers); *e*, vestigial female flowers (ovaries), without any known function, possibly degenerate by correlation of growth with the upper stamens; *f*, female flowers (ovaries), in a receptive condition.

[1] After completing my manuscript I have written as follows in the 'Illust. Zs. für Entomologie,' iii, 1878, p. 201 :—I had already found hundreds of specimens of Psychoda phalaenoides *L.* in the trap of Arum maculatum *L.*, at Iserlohn in Westphalia, and at Eutin. But in plants sent me on June 8 of this year from the Castle Garden of Plön I have observed a larger number of these little midges than I have previously seen. The traps were so full of them that free movement must have been impossible, so closely were they packed together. In one trap there were no less than 6 cc. of midges. These I spread out as evenly as possible on a surface of one sq. m., and counted those occupying one sq. cm. as being forty on an average. There must, therefore, have been some 4000 midges in all within one trap.

The extraordinary eagerness with which these midges visit the inflorescences of Arum is shown by

Visitors.—Herm. Müller often observed hundreds of individuals of Psychoda phalaenoides *L.* (identified by Winnertz, and = P. nervosa *Mg.*, perhaps also Tipula nervosa *Schr.*). I have also noticed similar numbers of the same species in woods near Eutin.

2909. A. italicum Mill. (Delpino, op. cit.; Knuth, 'Blütenbiol. Beob. a. d. Ins. Capri,' pp. 16–21.)—The flower mechanism in this species corresponds exactly to that of A. maculatum. While in the bud stage the inflorescence is firmly surrounded by the large spathe, which is still green in colour, this gradually becomes lighter and its upper part unfolds so that the yellow tip of the spadix becomes visible. In the mature stage the spadix of plants in Capri reach a length of 8 or even 10 cm., and two-thirds or three-quarters of it are yellow in colour and up to 1·5 cm. in diameter, while the lowest third or quarter is contracted into a sort of stalk 6 mm. long and concealed in the narrow part of the spathe.

Below the narrowest part of the spadix there are several whorls of vestigial flowers, attached to a thickened region, and produced into stiff bristles 5 mm. long and directed obliquely downwards. They touch the wall of the trap. A piece of the spadix only a few millimetres long divides them from the numerous male flowers, arranged in 5–7 whorls, and each consisting of but a single stamen. Immediately below these are situated several whorls of vestigial female flowers with almost vertical style-like processes about 5 mm. long, and finally, below these, the female flowers, also arranged in 5–7 whorls. Each of the latter consists only of an ovary directed obliquely upwards, with a stigma on the outer side, which has the appearance of a roundish spot not quite one mm. in diameter.

The female flowers mature before the spathe opens, while the male ones do not shed their pollen until after the ovary has shrivelled. The stigma, hitherto of a whitish-yellow colour, scarcely distinguishable from the ovary in colour, is then of a brownish tinge, while a large mass of pollen fills the base of the trap. After the anthers have scattered the pollen, the spathe fades, and the upper, yellow part of the spadix then usually falls off. When the trap-hairs shrivel, the lower narrowed part of the spadix with the female flowers falls off also, the spathe withers entirely, and the fruits ripen.

Arcangeli (Nuovo Giorn. bot. ital., Firenze, xv, 1883) states that the inflorescences open towards 1 p.m. and reach full maturity between 3–5 p.m. The stages of maturation are the same as those of Dracunculus vulgaris *Schott*. The odour is not perceptible. Arcangeli describes it as a mixed smell of mice, lemon, and decayed vegetable matter. The spathe also possesses an odour of magnolia or fruit at its base.

The pollinators are small flies which feed on decayed vegetable matter. Arcangeli counted 239 small Diptera in 56 inflorescences, 159 of them belonging to the genus Psychoda. Only 17 were dusted with pollen, the others having already deposited theirs on the stigma.

With regard to the flowers of A. italicum, Arcangeli states that the increase of

the fact that, when a trap was cut open, all the contained insects flew out and made their way into the trap of a second specimen held in readiness. It must be added that all the Arums so filled with Psychoda were in the second (male) stage of anthesis, with shrivelled stigmas and dehiscing anthers.

temperature is perceptible at 9 a.m., several hours before the opening of the inflorescences: the maximum, 40° C., is reached between 6–8.30 p.m. The spadix loses weight considerably during the increase.

Kraus (Abh. nat. Ges., Halle, xvi, 1884, pp. 35–76) observed that the evolution of heat inside the spathe rises to 40–44·7° C. in an air temperature of 17·7° C. This increase of temperature usually begins at the tip of the spadix, and spreads thence to its base. The oecological significance of this increase is that it induces the pollen-transferring midges to descend into the warm trap. As the visitors use the tip of the spadix as an alighting-platform, this becomes warm first and most strongly. The increase of temperature only takes place during the first (protogynous) stage of the inflorescence, and ceases when this is over.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Delpino ('Ult. oss.'), 6 Diptera (identified by Rondani)—1. Ceratopogon pictellum *Rond.*; 2. Chironomus byssinus *Schr.*; 3. Drosophila funebris *F.*; 4. Limosina pygmaea *Zett.* (= L. crassimana *Hal.*); 5. Psychoda nervosa *Schr.*; 6. P. nervosa *Mg.*; Knuth (Capri), numerous minute Diptera, and a staphylinid 4 mm. long.

2910. A. ternatum Thunb. (= Pinellia tuberifera *Tenore*). (Breitenbach, Bot. Ztg., Leipzig, xxxvii, 1879, pp. 687–92; Herm. Müller, 'Fertlsn.,' p. 564.)—The inflorescences in this species are protogynous. The pollen of the male flowers falls upon the small imprisoned insects (probably flies) which can then escape by a small opening.

2911. A. crinitum Ait. (Schnetzler, C.-R. Acad. sci., Paris, lxxxix, 1879, pp. 508–10.)—The flower mechanism of this species resembles that of A. maculatum. Carrion-flies are attracted by a strong smell of putrefying flesh. The smaller visitors cannot escape from the trap, but are held there firmly by sticky hairs and digested by their secretion.

Arcangeli (Nuovo Giorn. bot. ital., Firenze, xv, 1883) observed flies more particularly as visitors; in one spathe there were 385 Diptera, 107 of them belonging to the species Lucilia caesar *L.* The upper part of the spathe is bent like a knee, so that only the lower part forms the 'bridal chamber.' The upper part bears closely situated purple-red weel-bristles, directed obliquely downwards. The stigmas are as short-lived as those of Dracunculus vulgaris.

The plant is therefore adapted for pollination by Diptera. Such crowding of visitors into a single spathe as Arcangeli observed probably does not occur in a natural state; but in the plants examined was the result of the small number cultivated. This excess of visitors is indeed injurious to the plant, as they injure one another and die in the 'bridal chamber,' only a small number therefore emerging again during the fourth stage of anthesis.

2912. A. pictum L.—Arcangeli (Ric. ist. bot., Pisa, Fasc. 1, 1886, pp. 108–9) found 95 insects in one inflorescence in the Pisa Botanic Garden, consisting of 86 Borborus (Copromyza) equinus *Fall.*, 3 Aphodius melanostictus *Schmidt*, an Oxytelus nitidulus *Grav.*, 4 other smaller flies, and one hymenopterid (probably a parasite of Borborus).

The visitors were plainly attracted by the dark-purple colouring of the spathe

and the end of the spadix, and by the smell of the inflorescence, which resembles that of decaying fruit.

Martelli (Nuovo Giorn. bot. ital., Firenze, xxii, 1890, p. 129) adds that the protogynous inflorescences open in the morning. The stigmas are then receptive, but the anthers have not yet dehisced. The faecal odour is at its strongest in the upper part of the spadix, on which visitors alight. On the following day the anthers dehisce; the male flowers are situated on an inflorescence covered by a hood-like spathe.

2913. A. Dioscoridis Sibth. et Sm.—Caleri says that the spathe in this species opens early in the morning; between 8–9 a.m. it is visited by numerous flies (particularly muscids). The spathe then closes, the odour disappearing at the same time. On the second day the prisoners are set free. The stigmas of the protogynous flowers are therefore receptive for a very short time only.

940. Arisarum Targ. Toz.

2914. A. vulgare Targ. Toz. (= Arum Arisarum *L.*). (Delpino, 'Ult. oss.,' pp. 21–2; Knuth, 'Blütenbiol. Beob. a. d. Ins. Capri,' pp. 18–25.)—While in the island of Capri during March 1892 I could not observe the first stage of anthesis of this interesting species, because the plant was too far matured, but the flower mechanism was still easily distinguishable. Insects are attracted by the striped spathe and the projecting end of the spadix, and are temporarily imprisoned. At an early stage these two organs are of a greenish colour, the spathe below its arched tip being greenish with white longitudinal streaks. In a later stage the curved tip of the spadix, projecting 1·5–2 cm., is of a faint brownish tinge, and the hitherto greenish parts of the spathe assume the same colour, so that the upper, arched part of it appears to be brown, and the lower, cylindrical part is marked by about twenty brown and white streaks. Insects are attracted to the nectar, however, by the offensive, putrid smell of the inflorescence.

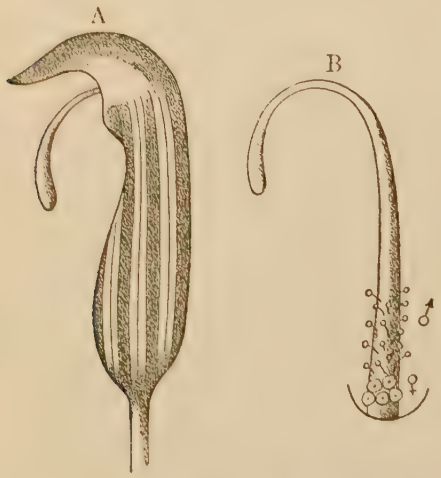


FIG. 411. *Arisarum vulgare*, *Targ. Toz* (from nature). *A*. Inflorescence with spathe intact. *B*. Do., after removal of spathe.

The spathe is about 4 cm. high, and the same in circumference. It is slightly contracted above, and roofed over by a pointed, dark-coloured lobe, bending over like a helmet, which keeps light from penetrating into the trap.

About ten female flowers are situated at the base of the spadix. Above them, loosely arranged for a distance of 1·5 cm., are the much more numerous (up to 40) male flowers, each consisting of a single short-stalked anther. The inflorescence is

protogynous, but the stigmas are still receptive when the anthers dehisce, so that autogamy is possible by fall of pollen. The insects attracted reach the trap either by creeping along the projecting spadix or along the inner surface of the spathe.

As a rule they are unwillingly detained there for some time, because they cannot find the opening again, this being, as already described, overhung and shadowed by the dark-coloured roof. In endeavouring to reach the open air once more, they always fly against the ten bright streaks on the spathe, through which the light shines, and after many attempts usually only regain their freedom by chance, when, wearied out, they begin to creep slowly to the top of the spadix. This barrier is so effective that the plant may be carried about for some time without the escape of a single insect from the trap, though if it is cut open they fly quickly away through the slit.

When pollination has been effected, the projecting part of the spadix shrivels up, while the arched lobe of the spathe folds down and completely closes the entrance. The offensive odour disappears at the same time, the spathe assumes an inconspicuous pale-reddish colour, and finally falls off, together with the upper part of the spadix.

Visitors.—Knuth (Capri) observed minute flies and midges, small ants, and an earwig (Forficula decipiens *Géné*).

2915. A. proboscideum Savi.—Arcangeli (Nuovo Giorn. bot. ital., Firenze, xiii, 1895) states that this species is pollinated chiefly by fungus-midges (Mycetophilidae). The upper part of the spadix serves partly to prevent the escape of insects, and also partly, no doubt, as nourishment for them later.

941. Dracunculus Adans.

2916. D. vulgaris Schott (= Arum Dracunculus *L.*).—Delpino ('Ult. oss.,' p. 2380) states that the flowers of this South European species are visited and pollinated by flesh-flies.

In Italy, however, Arcangeli (Nuovo Giorn. bot. ital., Firenze, xv, 1883) observed carrion-beetles as the chief visitors; in five inflorescences there were 463 beetles, 377 of them belonging to the species Saprinus nitidulus *F.*; he therefore describes the plant as 'necrocoleopterophilous.' As in Arum italicum *Mill.*, four stages of anthesis may be distinguished:—

(1) The spathe opens, the anthers being closed; the stigmas are receptive and are pollinated by beetles, which hasten, covered with pollen, to the flowers, attracted by the smell of carrion.

(2) The stigmas fade; the anthers still remaining closed.

(3) The anthers dehisce at the beginning of the second day; the carrion-beetle visitors dust themselves again with pollen.

(4) The lower part of the spadix, hitherto smooth as a mirror, becomes wrinkled, so that the carrion-beetles can climb up on it, reach the open air, and then pollinate other flowers.

Delpino and Mattei (Malpighia, Genova, iii, 1889–90, p. 38) assert that flies (Calliphora vomitoria *L.*, Sarcophaga carnaria *L.*, Lucilia sp. and so forth) may actually be considered pollinators, so that the plant is sapromyophilous. They also state that only flies are found in the traps of plants growing sporadically in woods.

Smooth beetles, not very skilful in flying, would scarcely be capable of transferring the pollen of this apparently adynamandrous plant. The wild plants visited by flies are, according to these investigators, very fertile, while the garden plants or garden escapes visited almost exclusively by carrion-beetles, remain sterile. The presence (smell?) of carrion-beetles seems to be the reason that flies do not visit such plants. The beetles appear to be attracted more by the imprisoned flies than by the putrid smell, and to have accustomed themselves later to the species because they find booty here. (*Cf.* Ludwig's abstract in 'Bot. Centralbl.,' Cassel, xlvi, 1891, pp. 38–9.)

Arcangeli, on the contrary, asserts (Malpighia, Genova, iv, 1890, p. 492) that he has observed several cases of direct pollination by means of beetles. Vinassa (Atti Soc. tosc. sci. nat., Pisa, vii, 1891, p. 317) confirms this.

The maximum temperature in the spathe is reached about 2.30 p.m., when it is 27° C. (as against 24·6° C.) air temperature.

In a later investigation (Boll. Soc. bot. ital., Firenze, 1897, pp. 293–300) Arcangeli found the maximum temperature between 8–10 a.m., when it was 28° C. in the spathe. A second maximum was observed in the afternoon. The air temperature at these times varied between 20·5° C. and 21·8 C.

Of these insects imprisoned in the 'bridal chamber' (149, 21, 200) this time only a decreasingly small number were beetles; most of them were Diptera, particularly the following 3 species—1. Limosina simplicimana *Rond.*; 2. Borborus equinus *Fall.*; 3. Sphaerocera pusilla *Fall.*, upon which the transfer of pollen devolved, while the presence of some Braconids was of secondary importance. Arcangeli did not observe ripe fruits.

Visitors. *Vide supra.*—J. J. Walker (Gibraltar, Ent. Monthly Mag., London, xxv, 1888–9, p. 33) observed carrion-flies (Calliphora vomitoria *L.*, and Scatophaga sp.), and carrion-beetles (Creophilus maxillosus *L.*, Dermestes vulpinus *F.*, and 3 sp. of Saprinus).

2917. D. canariensis Kunth.—This species is self-fertile in the Pisa Botanic Garden; Arcangeli, however, says (Nuovo Giorn. bot. ital., Firenze, xv, 1883) that cross-pollination is not excluded. Fruit-devouring insects, probably carpophilous beetles (Cetonia, Oxythyrea, and others), may be considered pollinators, as an odour of pine-apple and melon is perceptible during anthesis.

942. Arisaema Mart.

E. Baroni (Nuovo Giorn. bot. ital., Firenze, New Ser., iv, 1897) describes extra-floral nectaries in some species of Aroideae belonging to this genus, which were indigenous to China and cultivated in the Florence Botanic Garden. Nectar-receptacles are here found in the angles of the individual leaf-segments, which are no doubt of importance in cross-pollination. These species possess, particularly at the ends of the leaf-segments, appendages resembling the end of the spathe. The insects creep easily in the direction of the appendage to the nectaries, while others, misled by the similarity of the structure, reach the spadix by creeping over the spathe to that point on its inner surface where it is touched by the former. They creep thence on the spadix into the 'bridal chamber,' where they deposit and collect pollen. (*Cf.* Solla's abstract in Bot. Centralbl., Cassel, Beiheft vii, 1897–8, pp. 99–100.)

2918. A. filiforme Blume.—The remarks made by Delpino in No. 2925 apply here also.

943. Helicodiceros Schott.

2919. H. muscivorus Engl.—Arcangeli states that this species is pollinated by flies (species of Somomyia and Calliphora): 378 insects (371 flies and 7 beetles) were observed in one inflorescence. In opposition to Schnetzler, Arcangeli is of

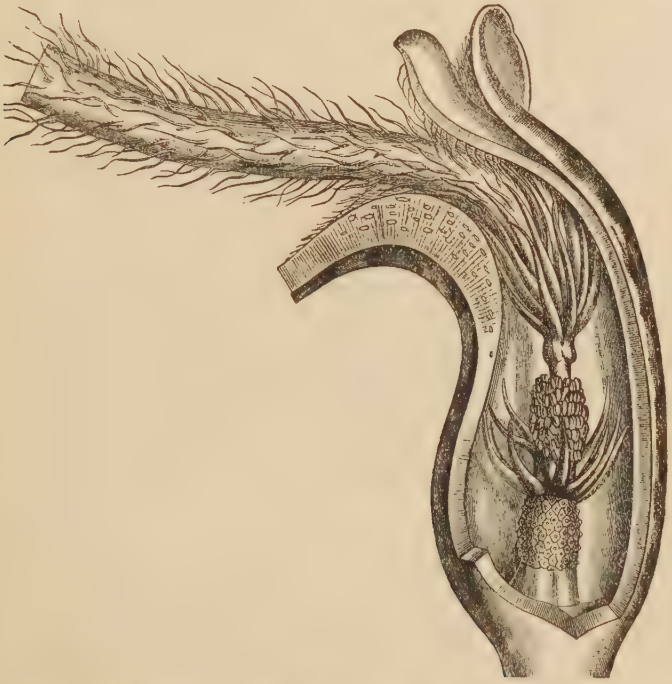


FIG. 412. *Helicodiceros muscivorus, Engl.* (after A. Engler). Lower part of spadix and spathe. The upper part of the former (not figured) resembles the lower part.

opinion that insects visiting the inflorescences only effect crossing, and do not serve as nourishment for the plant, as the necessary secretory organs are absent from the inflorescences, and the fly-larvae developing in it live for some time.

944. Sauromatum Schott.

2920. S. guttatum Schott.—Delpino (Malpighia, Genova, iv, 1890) states that the flower mechanism of this species resembles those of Arum italicum *Mill.* and A. maculatum *L.*

945. Amorphophallus Blume.

2921. A. Rivieri Dur.—Pirotta (Nuovo Giorn. bot. ital., Firenze, xxi, 1889, p. 156) says that a plant of this species cultivated in the Rome Botanic Garden is necrocoleopterophilous, for 122 carrion-beetles were once found in the inflorescence, these belonging to nine species and six genera: Saprinus nitidulus *F.* (65) was the most numerous, and S. aeneus *F.* (30) came next.

2922. A. Titanum Becc. (Beccari, Bull. R. soc. tosc. ort., Firenze, xiv,

1889.)—In this species, bearing 'the largest flower in the world,' there is a huge spathe in the form of a bright green funnel, white above, with a rich wine-red inner surface. The cream-yellow spadix, attaining a length of 1½ m., projects from this cup (1·20 cm. broad), its penetrating smell of flesh attracting swarms of flies in its native place, Sumatra. These enter the lower part of the spathe and effect pollination.

2923. A. campanulatus Blume (= Arum campanulatum *Roxb.*).—Delpino ('Ult. oss.,' p. 238) supposes that this East Indian species is pollinated by flesh-flies. Arcangeli (Nuovo Giorn. bot. ital., Firenze, xv, 1883) says that the visitors are almost exclusively carrion-loving beetles of the genera Saprinus, Dermestes, and Oxytelus.

2924. A. variabilis Blume.—Delpino (op. cit.) supposes this species to be pollinated by snails.

946. Typhonium Schott.

2925. T. cuspidatum Decne.—Delpino (op. cit.) supposes this species to be pollinated by snails, which are attracted by its pleasant odour, creep through a narrow opening to the female flowers, which are surrounded by the spathe and mature first. The snails will pollinate the stigmas if they come from inflorescences in the second stage with mature anthers. After pollination has been effected, the opening which leads to the female flowers closes, and the snails still present in the cavity are killed by a caustic (corrosive) liquid now secreted inside the spathe, being thus prevented from devouring the inflorescence.

947. Pinellia Tenore.

2926. P. tripartita Schott (= Atherurus tripartitus *Blume*).—As No. 2925.

948. Anthurium Schott.

Species of this genus agree with No. 2925.

2927. A. Pothos.—Delpino ('Altri appar. dicog. recent. oss.,' p. 62) describes this species as protogynous, with short-lived stigmas.

949. Alocasia Neck.

2928. A. odora C. Koch.—As No. 2925.

950. Ambrosinia L.

2929. A. Bassii L. (Delpino, 'Ult. oss.,' pp. 230–1.)—In flowers of this species the stigmas are situated outside at the end of the spadix, and the anthers inside the spathe, so that fly visitors must first touch the former and then the latter, thus always effecting cross-pollination.

951. Stylochiton Lepr.

2930. S. hypogeum Lepr., and **2931. S. lancifolius** Kotschy et Peyr.—Engler ('Pflanzenleben unter d. Erde') states that the inflorescences in these species, consisting of male and female flowers, are surrounded by a spathe and remain below the ground. Only the tip projects, and the insects effecting pollination creep down from this to the male and female flowers below.

952. Biarum Schot., and 953. Cryptocoryne Fisch.

The flower mechanisms of species belonging to these genera resemble that of Nos. 2930 and 2931.

954. Calla L.

Protogynous, hermaphrodite flowers, closely crowded on a fleshy spadix, with a shallow spathe.

2932. C. palustris L. (Herm. Müller, 'Weit. Beob.,' I, pp. 283–4; Warming, 'Smaa biol. o. morfol. Bidrag'; Engler u. Prantl, 'Araceae,' in 'D. nat. Pflanzenfam.,' II, 4; Knuth, Bot. Centralbl., Cassel, li, 1892, pp. 289–91, 'Beiträge,' I.)—The large, externally greenish spathe in this species surrounds the short-stalked inflorescence during the bud stage. When it unfolds it is about 3 cm. broad and 4 cm. long, and ends in a cornet-shaped tip almost a cm. long. This large, ovoid plate, white inside with a faint greenish tinge, serves as a 'sign-board.' The conspicuousness is still further increased by the short-stalked spadix, which is about 1·5 cm. long and 0·8 mm. in diameter. Herm. Müller describes the flowers as nauseous, on account of their disagreeable odour.

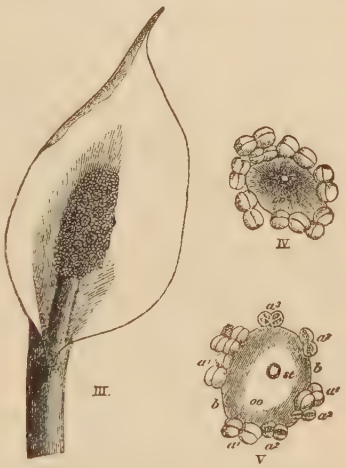


FIG. 413. *Calla palustris*, *L.* (after Herm. Müller). III. Inflorescence (×⅔). IV. Single flower in the first (female) stage: the anthers are still closed, the ovary (*ov*) ends in an ovoid one, the truncated end of which forms the stigma (*st*); this is now fresh, greenish in colour, and receptive. V. Single flower in the second (male) stage: the stigma (*st*) has become brown; the anthers are partly closed (a^1), partly dehisced and covered with pollen (a^2), while one (a^3) is already empty; the ovary has swollen so much that at *b b* it has become feathered by pressing against the ovaries of adjacent flowers. (× 5.)

The flowers are markedly protogynous. The 30–50 stigmas appear in the first stage of anthesis as small, whitish circles, strongly papillose and viscous, on the ovaries. Those of the lower ones are receptive immediately after the opening of the spathe. The anthers only dehisce when some stigmas have shrivelled. In the first stage they are sessile; in the second they develop short stalks, so that they are raised to the level of the stigmas. Engler points out that the anthers dehisce quite without order, those of flowers situated above and below dehiscing simultaneously, while the stigmas always mature from below upwards, and in such a manner that the stigmas of the uppermost flowers and those facing the spathe can be self-pollinated, while the lowest are limited to cross-pollination.

VISITORS.—The following were recorded as stated.—

Knuth, a few small flies: also (4. 8. '97, in the Kiel Oberrealschule Garden) a young individual of Helix hortensis *L.*, creeping over the inflorescence. Examination of its foot showed the presence of pollen-grains, and demonstrated the possibility of malacophily in this species. Herm. Müller, numerous small Diptera, e. g. Drosophila graminum *Fall.*, Hydrella griseola *Fall.*, and species of Chironomus and Tachydromia; also, as casual visitors, a few small beetles—Cassida nobilis *L.*, Aphthonia caerulea *Payk.*, Meligethes sp., Hypera polygoni *L.*, and Sitona sp. Warming mentions snails

as occasional visitors; they creep over the crowded anthers and stigmas forming a continuous surface, and easily transfer pollen to the latter.

955. Acorus L.

Protogynous, sessile, hermaphrodite flowers, arranged on a spheroido-cylindrical spadix.

2933. A. Calamus L. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 402; Ludwig, 'Zur Biol. d. phanerog. Süsswasserflora,' p. 128; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 139–40.)—The spadix of this species, up to 10 cm. long and $1\frac{1}{2}$ cm. thick, is completely covered by several hundred (700–800) closely-crowded flowers, each possessing a sessile, punctiform stigma and six stamens, 12 mm. long. Formation of the berry-like fruits has never been observed in Europe, though they set in Japan and India. Ludwig ascribes this to the circumstance that all European Calamus plants are supposed to have been derived from a single stock, introduced by Clusius. According to this, the species is adynamandrous.

This attempted explanation seems to me more probable than the one given by Kerner, who says that the species of Calamus set no fruit in Europe because the insects which pollinate them are absent. Autogamy is completely excluded by marked protogyny; and Kerner says that geitonogamy cannot take place automatically by fall of pollen, this being adherent, but can only be effected by the help of insects. Judging from the construction of the spadix, all our native Diptera and Hymenoptera would be able to transfer pollen; but insect-visits have not yet been observed in Europe. Warnstorf describes the pollen-grains as yellowish in colour, very small, ellipsoidal to oval, glabrous; about 12 μ broad and 18–22 μ long. (*Cf.* Loew, 'Blütenbiol. Floristik,' p. 363.)

CXXI. ORDER *LEMNACEAE* LINK.

956. Lemna L.

Literature.—Ludwig, 'Süsswasserflora,' pp. 38–40; Trelease, Proc. Soc. Nat. Hist., Boston (Mass.), xxi, 1882, pp. 410–15; Hegelmaier, 'Lemnaceae,' in Engler u. Prantl's 'D. nat. Pflanzenfam.,' II, 3; Delpino, Riv. bot. dell' anno 1880; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 138; Warming, Verh. bot. Ver., xxxviii, 1896.

2934. L. arrhiza L. (= Wolffia Michelii *Schleid.*); **2935. L. trisulca** L.; **2936. L. minor** L.; and **2937. L. gibba** L.—Hermaphrodite or monoecious species, seldom flowering in Germany. Propagation is therefore almost exclusively effected by the sprouting of the thalloid, usually lens-shaped, floating stem. L. arrhiza does not flower at all in Germany, but only in warmer regions. The accounts of the flower mechanism given by different investigators are contradictory in part, but may, in Ludwig's opinion, all be correct, as the mechanism of the same plant may vary in different regions.

As I have never had an opportunity of observing species of Lemna in flower, I will give Ludwig's description of the oecology of L. minor, as he observed them in a room, and in a sheltered pond in the neighbourhood of Greiz from May to July. The monoecious inflorescence consists either of one short-styled pistil above and two

stamens situated at a lower level, and upwardly directed like it, or pistil and stamens, surrounded by an irregularly torn involucre, all situated on different parts of the thallome.

The two stamens mature successively, considerably earlier than the stigma. Automatic self-pollination is excluded by this protandry, and also by the relative position of stigma and anthers. It is incredible that the wind plays a part in pollination, on account of the shortness and stiffness of the stamens and the small quantity of pollen. In spite of its entire lack of attractions Ludwig considers the flowers entomophilous, and to be visited by insects which play on the surface of the water, particularly the gregarious water-measurers (species of Hydrometra), which propel themselves by fits and starts with a rowing movement. The structure of the pollen-grains favours the theory of entomophily, for they are prickly and beset with numerous processes. The diameter of a pollen-grain is 26 μ and the length of its spines about one μ. The grains cling easily therefore to the bodies of insects brushing over the anthers, and can be conveyed by them to the somewhat concave stigmatic disk. Insects playing on or between the Lemna clumps at once touch both anthers and stigma, so that the plant needs no special means of attraction and no equivalent reward (perhaps the offering of a firm substratum may be considered as such). Species of Lemna therefore attain what ordinary 'flowers' gain by the development of bright colouring, nectar, and fragrance.

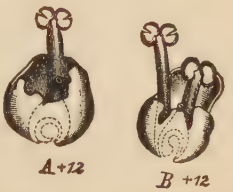


FIG. 414. *Lemna trisulca*, L (after A. Engler). Inflorescence in two successive stages.

Trelease found the plant protogynous. He thinks that the Lemna clumps are crowded together by currents of water and wind in order that the little plants in the female stage may easily come into contact with those in the male stage, and pollination be thus effected. He also says that self-pollination is not excluded in the plants observed by him, as one stamen matures three days later than the stigma, and the latter is then still receptive; the second stamen dehisces after three days more.

Hegelmaier also describes L. minor as protogynous; but the stigma is still receptive when the anthers dehisce, so that automatic self-pollination takes place, while crossing is improbable.

Delpino agrees with Ludwig's explanation of the mechanism; he supposes that water snails must also be considered as pollinators.

Kalberlan (Zs. Natw., Stuttgart, lxviii, 1894, pp. 136–8) describes Lemna as protogynous and probably pollinated by insects.

L. Vuyck (Bot. Jaarb. Dodonaea, Ghent, vii, 1895, p. 72) found flowering plants of Lemna in Holland in the summer of 1894. These were always protogynous-dioecious. The inflorescences agreed exactly with the description given by Hegelmaier, but Vuyck found that the funnel-shaped stigma secretes a fluid containing a great deal of sugar, so that it acts as a nectary. The division of labour is not very far advanced in this small, simply-constructed plant, for here one organ serves purposes divided among several in other flowers.

According to this the flower, or rather the inflorescence, is entomophilous; but Vuyck observed no insect-visits. The fact that the pollen-grains are beset with

spines also points to entomophily. Propagation by cross-pollination, however, scarcely ever occurs on account of the rareness of flower formation; it is therefore very extensively carried on by vegetative means. Although the plant may be thus self-propagated, Vuyck considers it doubtful whether cross-pollination is not necessary, after some asexual generations, in order to maintain the vigour of the stock.

Warnstorf describes the small primary stem in German species of Lemna as presenting two lateral basal notches when propagating vegetatively, from which proceed symmetrically two equivalent lateral shoots, that behave like the primary one. The continuous chain of connected individuals which we see in L. trisulca is thus formed. In flowering specimens this tendency to shoot-formation is considerably less prominent, and the lateral shoots are very limited in number. L. trisulca, L. minor and L. gibba generally develop only one secondary leaf-shoot from the notch on the right or left side, and in L. trisulca (unlike its condition in sterile plants) this is always sessile; the corresponding lateral shoot on the other side is fertile, and modified into an inflorescence enclosed in a delicate involucre, and consisting of a terminal pistil and two stamens situated immediately below the ovary. In rare instances the inflorescence is absent altogether, or the pistil or stamens only may be present.

The delicate style with its funnel-shaped stigma always protrudes first from the notch in the thallome, and as it bends upwards, the stigmatic funnel raises a little drop of water, that rests upon it like a crystal globe. The style only projects about $\frac{1}{2}$ mm. above the surface of the water, and has usually disappeared by the time the first stamen is mature and protrudes; the stigma, however, sometimes remains receptive, and in that case autogamy can easily take place. The second stamen does not project from the notch until the anther of the first has scattered its spinose, adhesive, tetrahedral pollen-grains, which are about 25 μ in diameter. While the flower of the primary shoot fades, the lateral shoot situated opposite projects more and more from the notch in the thallome, and matures a second inflorescence resembling the first. If the secondary vegetative shoot was developed in the right notch, this new inflorescence appears in the left one, and conversely. Warnstorf never observed the development of more than one inflorescence. It is striking that the upper half of the primary shoot in flowering plants of L. trisulca is always curved downwards in the form of a bow and is submerged, while the middle and lower parts float.

By close observation of flowering duckweed in an aquarium Warnstorf proved the following.—

(1) German species of Lemnaceae (L. trisulca, L. minor, and L. gibba) are markedly protogynous.

(2) The stigma is sometimes still receptive when the first stamen has dehisced, so that in this case autogamy can easily take place.

(3) In consequence of the gregarious habits of lemnaceous plants, pollen from flowers in the second (male) stage can easily reach those in the first (female) one by mutual contact of different plants, and cross-pollination thus take place.

(4) The wind can easily wash the floating pollen into the funnel-shaped stigma or bring plants in different stages so near that mutual pollination can be effected.

(5) There is also a possibility of pollination by small water-spiders, water-beetles, and snails (Planorbis).

Thus in the pollination of species of Lemnaceae, wind, water, and animals perhaps play equal parts; cross-pollination without outside help, however, and even autogamy are in no way excluded, as a result of the gregarious habits of plants of the species.

2938. L. polyrrhiza L. (= Spirodela polyrrhiza *Schleid.*). (G. Engelman, Bull. Torrey Bot. Cl., New York, 1870, pp. 42–3; H. Gillman, Amer. Nat., Boston (Mass.), xv, 1881, pp. 896–7.)—Engelman describes this species as protandrous. Gillman observed that the stamens, which dehisce about 4 p.m., move back at night, and open again the next morning between 7–9 a.m.

CXXII. ORDER *ALISMACEAE* JUSS.

Literature.—Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 133.

Flowers hermaphrodite or monoecious, rarely dioecious. The inner or both perianth whorls are petaloid, and therefore serve to attract insects.

957. Alisma L.

Flowers hermaphrodite and homogamous, white or reddish in colour; with half-concealed nectar secreted by a ring at the base of the stamens.

2939. A. Plantago L. (Herm. Müller, 'Fertlsn.,' p. 565; Kirchner, 'Flora v. Stuttgart,' p. 183; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 133; Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)—The homogamous flowers of this species are arranged in pyramidal panicles, and possess a yellow nectar-guide at the base of each of the three white or reddish petals; they expand to form a surface about 10 mm. in diameter. Hermann Müller says that nectar is secreted in twelve small drops by the inner side of a fleshy ring formed by the union of the broadened bases of the six filaments. The stamens are directed obliquely upwards and outwards, and turn their pollen-covered surface outwards, while the stigmas stand erect in the middle of the flower. The most frequent visitors are hover-flies, which by flying to the centre effect

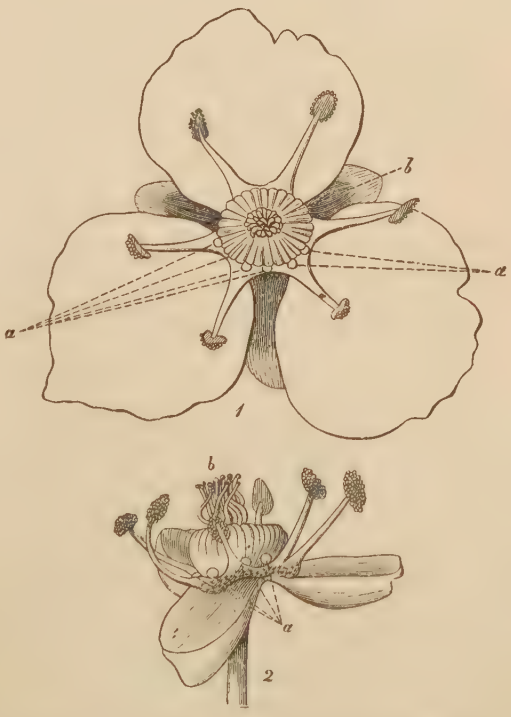


Fig. 415. *Alisma Plantago, L.* (after Herm. Müller). (1) Flower seen directly from above. (2) Lateral view of do., after removal of the petals. *a*, droplets of nectar; *b*, stigmas.

cross-pollination, if they come from another flower, but are able, on the other hand, to bring about self-pollination if they alight on a petal. Warnstorf describes the pollen-grains as yellow in colour, polyhedral, on an average 25 μ in diameter.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller (H. M.) and Knuth (Kn.), 7 hover-flies, skg. and po-dvg.—1. Ascia podagrica *F.* (H. M.), very numerous; 2. Eristalis arbustorum *L.* (Kn.); 3. E. sepulcralis *L.*; 4. Melanostoma mellina *L.* (Kn., H. M.); 5. Melithreptus scriptus *L.* (H. M.); 6. Syritta pipiens *L.* (Kn., H. M.); 7. Syrphus ribesii *L.* (Kn.). MacLeod (Flanders), a short-tongued bee, 4 hover-flies, and 5 Muscids (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 289), Scott-Elliot (Dumfriesshire), a short-tongued bee, 8 hover-flies, 5 Muscids, and a Lepidopterid ('Flora of Dumfriesshire,' p. 164).

958. Echinodorus Rich.

2940. E. ranunculoides Engelm. (= Alisma ranunculoides *L.*).—In flowers of this species the three petals are white with a faint tinge of pink and a basal yellow blotch; they are about 8 mm. long and 10 mm. broad at the widest part; the diameter of the flower is therefore about 15 mm. As only a few such flowers are united into a panicle and the secretion of nectar is small, visitors are naturally rare. Automatic self-pollination is therefore ensured, the six short, vertical stamens projecting beyond the stigmas, which mature simultaneously with them, autogamy by fall of pollen being thus inevitable. Should insects visit the flowers, however, cross-pollination is also possible.

959. Elisma Buchen.

2941. E. natans Buchen. (= Alisma natans *L.*, and Echinodorus natans *Engelm.*).—Hildebrand ('D. Geschlechts-Vert. b. d. Pfl.,' p. 90) and Kerner state that submerged flowers of this species fertilize themselves pseudo-cleistogamously.

960. Sagittaria Rupp.

Monoecious pollen-flowers (?).

2942. S. sagittifolia L.—The diameter of the male flowers of this species was about 2 cm. in the plants which I examined near Kiel; female flowers may be at once distinguished by their smaller size. The white petals possess a brilliant red nectar-guide at their base, which suggests the presence of juicy tissue. When treated with Fehling's solution and orthonitrophenylpropionic acid (*cf.* Leucojum aestivum *L.*) there was no deposition of colouring matter in the male flowers.

The plants in the neighbourhood of Kiel seemed to be protogynous, for the female flowers were already faded when the pollen-flowers opened. Fruits are set scantily.

Kölreuter pointed out ('Dritte Fortsetzung') that anemophily is improbable or at least very doubtful. Hildebrand (op. cit., p. 9) observed a plant of which the male and female flowers were not normal. He says (Bot. Ztg., Leipzig, li, 1893) that the male and female flowers are situated in separate whorls.

Warnstorf (Verh. bot. Ver., Berlin, xxxviii, 1896) says that the lower female

blossoms of the inflorescence open first, and then the pseudo-hermaphrodite pollen-flowers above them, so that the species is protogynous in the neighbourhood of Neu-Ruppin. The anthers are of a beautiful dark-brown colour, and dehisce laterally. The pollen-grains are yellow, rounded polyhedral, closely beset with short spines, and therefore clinging to the dehisced anther-lobes, about 27–31 μ in diameter.

Warnstorf distinguished the following variations in the inflorescences at Ruppin.—

(1) The lowest of the trimerous whorls contains female flowers only, and the one above this 1–2 such flowers, while the rest are entirely composed of pseudo-hermaphrodite pollen-flowers.

(2) One of the female flowers of the lowest whorl is replaced by a branch bearing pseudo-hermaphrodite pollen-flowers; otherwise as (1).

(3) There is only one female flower in the lowest whorl, the other two being replaced by branches bearing pseudo-hermaphrodite pollen-flowers only. This is rare.

(4) The lowest whorl possesses one female flower, a single pseudo-hermaphrodite pollen-flower, and two branches bearing pollen-flowers only.

(5) Instead of the one female flower in the lowest whorl there is a pseudo-hermaphrodite male flower with a branch in the axil of its bract bearing flowers of the same kind.

(6) The lower whorl consists of one female flower, three male flowers, and two flower-branches bearing male flowers. Very rare at Ruppin.

Visitors.—MacLeod observed 3 Muscids in Flanders (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 288).

961. Butomus Tourn.

Flowers homogamous to protandrous, with half-concealed nectar secreted at the base of the ovary.

2943. B. umbellatus L. (Sprengel, 'Entd. Geh.,' p. 234; Herm. Müller, 'Weit. Beob.,' I, p. 293; Kirchner, 'Flora v. Stuttgart,' pp. 182–3; Schulz, 'Beiträge,' I; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 133–5.)—The flower mechanism of plants belonging to this species seems to vary in different districts, for the descriptions of Sprengel, Hermann Müller, and A. Schulz differ considerably. I will therefore first give an account of the mechanism as I have observed it in Schleswig-Holstein. About twenty flowers form a terminal umbel, and the diameter of each flower is about 4 cm. Both sepals and petals are pale-pink in colour, darker in the middle and towards the base. The stamens and, in the second stage of anthesis, the carpels also, are dark-red; they thus help to make the flowers conspicuous. In the island of Föhr and near Kiel I observed rather marked protandry. There are nine stamens, and the anthers of the six which are not superposed on the petals dehisce first, their filaments at the same time bending backwards and outwards. When these six have withered, the anthers of the other three dehisce, but their filaments remain fairly erect. The carpels now mature. The ovaries, hitherto pink on the outer margin only, become dark-red, and the stigmas appear in the form of slits, which expand gradually to such an extent that they are brought below the still pollen-covered anthers of the three stamens which matured last. In the first part of

the hermaphrodite stage, therefore, cross-pollination will be effected by insect-visits if visitors bring foreign pollen and alight on the stigmas in the middle of the flower. In the second part of this stage both cross- and self-pollination may be brought about by insect-visits; autogamy takes place by fall of pollen should such visits fail. I could observe the latter in plants which flowered in my laboratory; the pollen of the three inner stamens fell so plentifully on the carpels that not only were the stigmatic papillae thickly covered with it, but a large portion rolled down the inner side of the ovary into the base of the flower. In the first (purely male) stage such masses of pollen may always be found in the trough-like hollows of the sepals and petals, whence it is removed by gusts of wind. The shallow form of the stigmas, however, renders it scarcely possible for the pollen to be deposited on them by such means.

Nectar is so abundantly secreted on the carpels that there is always a large drop in the cleft between each two adjacent ovaries.

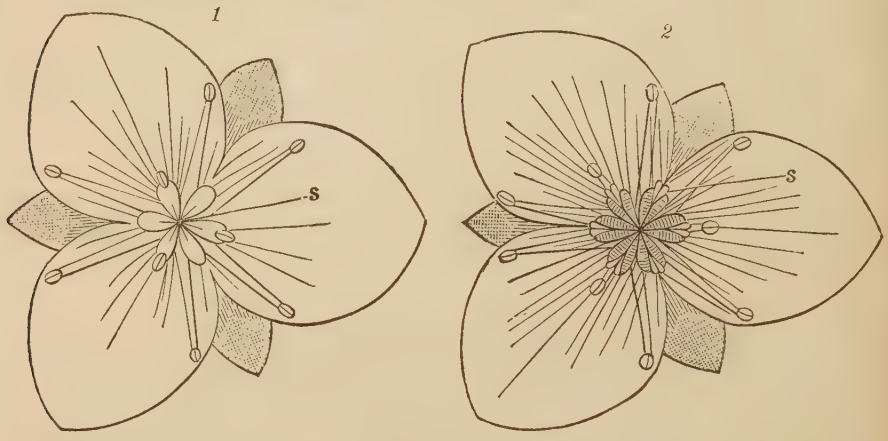


FIG. 416. *Butomus umbellatus*, *L.* (from nature). (1) Flower in the first (male) stage: 6 stamens have developed, diverging from the centre and opening their anthers; the stigmas are still immature. (2) Do., in the second (hermaphrodite) stage: all the anthers have dehisced, but the innermost stamens have only diverged slightly; the stigmas have become receptive. The pollen in the dehisced anthers is not indicated. *s*, stigmas.

Sprengel's account differs from mine in stating that all nine anthers have already lost their pollen when the stigmas mature, so that automatic self-pollination seems to be excluded. Hermann Müller, on the contrary, says that all nine anthers remain well covered with pollen until the stigmas are fully receptive, and come into contact with them partly automatically, autogamy being brought about in this way.

A. Schulz found flowers near Halle to be usually homogamous or feebly protandrous, more rarely markedly protandrous. There the stigmas are frequently divergent and papillose when the flower opens, but usually they only become fully receptive by the time some of the anthers have dehisced. The stamens are curved at the base and shorter than the pistil; the laterally dehiscing anthers are therefore situated 2–4 mm. below the stigmas, so that in the usually upright flowers automatic self-pollination seems to be excluded, as a rule, and is only possible in occasional cases, when stigmas and anthers are at the same level.

Jordan points out further that the three petals form an alighting-platform, from which the entrance leads between the stamens to the middle of the flower. Warnstorf describes the pollen-grains as saffron-yellow in colour, biscuit-shaped, closely tuberculate, about 25 μ broad and up to 37·5 μ long.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller, the fossorial wasp Gorytes fargei *Schuck.* (=G. campestris *L.*) ♂, skg. Knuth ('Bl. u. Insekt. a. d. nordfr. Ins.,' p. 167), 3 hover-flies, several bees, and 2 Lepidoptera. Heinsius (Holland).—**A. Diptera.** (*a*) *Empidae*: 1. Empis livida *L.* ♂. (*b*) *Muscidae*: 2. Anthomyia sp. ♂; 3. Onesia floralis *R.-D.* ♂; 4. Pyrellia cadaverina *L.* ♀; 5. Scatophaga stercoraria *L.* ♀. **B. Hymenoptera.** (*a*) *Apidae*: 6. Halictus leucopus *K.* ♀. (*b*) *Sphegidae*: 7. Crabro cribrarius *L.* ♂ and ♀ (Bot. Jaarb. Dodonaea, Ghent, iv, 1892, p. 68). H. de Vries (Netherlands), 2 humble-bees—Bombus subterraneus *L.* ♀, and B. terrester *L.* ♂ (Ned. Kruidk. Arch., Nijmegen, 2. Ser., 2. Deel, 1875). MacLeod (Flanders), 2 hover-flies (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 291). Schiner (Austria, *teste* Egger), the hover-fly Melithreptus formosus *Egg.*

CXXIII. ORDER *NAIADACEAE* LINK.

962. Naias L.

Flowers monoecious or dioecious and adapted for pollination by water. The pollen-grains possess no extine, are globular or ellipsoido-cylindrical in the closed anther, and tube-shaped when examined in water.

2944. N. major All. (Magnus, 'Sur les phénom. de la pollin. dans les pl. du gen Najas'; Jönsson, 'Om Befrukt. hos Slägtet Najas, etc.'; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 105.)—The flowers of this species are dioecious. The male blossom consists of one stamen only, bearing a terminal four-lobed anther, and surrounded by a two-layered, closed involucre, the outer layer produced into a toothed beak, while the inner is united to the wall of the anther almost to the tip. This inner layer splits into four lobes which roll backwards, and the pollen then escapes into the water. Jönsson states that the pollen-grains, owing to the large number of starch-grains which they contain, are heavier than water, and so sink down and are caught by the stigmas of the female-flowers, which consist only of an ovary with 2–3 stigmatic branches. Magnus says that the pollen-grains have already developed tubes in the dehisced anther.

2945. N. flexilis Rostk. et Schmidt (= Caulinia flexilis *Willd.*). (Jönsson, op. cit.; Magnus, op. cit.)—The flowers of this species are monoecious. The male blossoms, according to Jönsson, are situated higher on the plant and are more numerous than the female ones. The inner involucral layer of the former, united to the wall of the anther, splits into two valves. The female flower bears two stigmatic branches and two spiny ones.

963. Scheuchzeria L.

Flowers probably anemophilous and protogynous.

2946. S. palustris L. (Buchenau, in Engler's 'Pflanzenreich,' Leipzig, Heft 16.)—The dull-brownish green perianth leaves of flowers belonging to this species

are irregularly expanded. The upwardly tapering filaments bear inverted anthers, which contain smooth, easily scattered pollen. The stigma forms a bipinnate brush with long, transparent papillae, and springs from a little below the tip of the ovary. The stigma no doubt matures before the anthers.

964. Triglochin Riv.

Literature.—Axell, 'Om Anord. för Fanerog. Växt. Befrukt.,' p. 38; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 135–6; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 148; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 291.

Protogynous wind flowers. The hexaphyllous calyciform perianth serves as a temporary receptacle for pollen falling from the stamens situated above. The anthers of the lower staminal whorl dehisce first, and then those of the upper one. Kerner says that the stigmas mature 2–3 days before the anthers.

2947. T. maritimum L. (Knuth, loc. cit.)—During the first stage of anthesis in this species the somewhat pinnate papillose stigmas protrude from the perianth leaves, which at first still remain closed like a bud. The latter are carinate in form, and greenish in colour with reddish tips; later on they are forced apart by the swelling of the ovary, and the three sepals bend slightly backwards, but in such a way that their tips, which gradually become brown in colour, always remain in contact with the ovary. In this way three crescentic pockets are formed, behind each of which an anther dehisces, part of the pollen falling into it. On being lightly touched, and by every gust of wind, the pollen is scattered from the pockets and also from the anthers if they still contain any. The sepals, which have become dry and skin-like, become loose, and are carried away by gusts of wind with the pollen lying in them and the anthers united to their bases. When the calyx has been removed in this manner the same process takes place with the corolla. Warnstorf describes the pollen-grains as yellowish-white in colour, very irregularly tetrahedral, tuberculate, 25–31 μ in diameter.

2948. T. palustre L. (Knuth, op. cit., p. 136.)—This species possesses the same flower mechanism as the preceding one. Warnstorf describes the pollen-grains as whitish in colour, spheroidal to ovoid, closely tuberculate, 31 μ in diameter on an average.

A very delicate small-flowered variety of this species, with slender stems, occurs in Greenland (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' p. 78).

965. Potamogeton L.

Literature.—Axell, 'Om Anord. för Fanerog. Växt. Befrukt.,' p. 38; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 283–5; Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' pp. 136–7.

Aquatic plants bearing protogynous, anemophilous, hermaphrodite flowers. Perianth absent, but replaced by four scale-shaped connectives. Kerner states that the pollen falls first of all into a cavity in the connective (at any rate in P. crispus *L.*).

2949. P. natans L. (Knuth, op. cit., p. 137.)—In this species the closely-crowded spike consists of some 50 flowers about 4–5 mm. in diameter. In the first (female) stage it is about 4 cm., in the second (male) one about 6 cm. long, and just projects from the water. The four green perianth-like connectives are at first closed like an envelope, with only the four brush-shaped stigmas projecting. These are dusted by means of the wind with pollen from adjacent flowers already in the male stage. The connectives then diverge, and the eight sessile anther-lobes dehisce and empty their abundant dusty pollen.

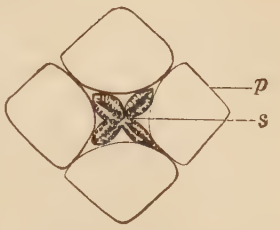


FIG. 417. *Potamogeton natans*, *L.* (from nature). Flower in the first (female) stage, seen from above. *p*, scale-like connectives; *s*, receptive stigma (× about 6).

2950. P. perfoliatus L. (Warnstorf, Verh. bot. Ver., Berlin, xxxvii, 1896.)—The stalks of the connective-plates of the protogynous wind flowers belonging to this species are vertical to the ovary when the pollen is mature, while their expanded parts are parallel to it. In this way is constituted an excellent arrangement for catching the pollen carried by the wind. The pollen-grains are ovoid to ellipsoidal, white in colour, slightly transparent, delicately retiform-tuberculate, about 44–50 μ long and 37·5 μ broad.

2951. P. crispus L. (Warnstorf, op. cit., xxxviii, 1896.)—The flowers of this species are protogynous and the anthers extrorse. The pollen-grains are white, spheroidal to ovoid, almost glabrous, from 37–47 μ in diameter. MacLeod (Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 284–5) gives a detailed description of the flower mechanism, corresponding for the most part with my account of P. natans.

2952. P. lucens L. (Warnstorf, op. cit.)—The pollen-grains in this species are whitish in colour, irregularly tetrahedral, from 25–8 μ in diameter.

2953. P. gramineus L., var. (a) *gramineus* Fr. (Warnstorf, op. cit.)—The pollen-grains in this species are white in colour, irregularly tetrahedral, almost retiform-tuberculate, from 31–5 μ in diameter.

2954. P. pusillus L. (Warnstorf, op. cit.)—The pollen-grains in this species are flour-white in colour, tetrahedral, closely tuberculate and opaque, varying in size, on an average 25 μ in diameter.

2955. P. filiformis Pers. (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlands-exped.,' p. 78.)—Vanhöffen observed nearly ripe fruits of this species in Greenland.

966. Ruppia L.

Flowers hermaphrodite, hydrophilous, and usually protandrous. The pollen-grains possess no extine.

2956. R. maritima L. (= R. spiralis *Dumort.*). (Delpino u. Ascherson, 'Corrispondenza'; H. Schenck, 'Biol. d. Wassergewächse,' p. 123; Roze, Bul. soc. bot., Paris, xli, 1894, pp. 466–80.)—The flowers of this species possess no perianth, and consist of two stamens and four carpels. The spadix is made up of only two such flowers, situated on opposite sides of the axis. In the first stage the spadix is male; it is then short and scarcely projects from the sheath of the bract. The

anthers empty their pollen-grains under water; these are cylindrical in shape and bent like a knee; they possess no extine, and their specific gravity is so small that they rise at once to the surface of the water.

In the second (female) stage of the spadix its stalk has elongated so greatly that the now mature ovary reaches the surface of the water, where the pollen is blown to it by the wind. Much as in Vallisneria the stalk of the spadix draws back below the surface of the water when pollination has been effected, and the fruits mature there.

2957. R. rostellata Koch. (Delpino u. Ascherson, op. cit.; H. Schenck, op. cit.)—The construction of the flowers and the course of maturation of the stigmas and anthers are the same as in the preceding species, but this one is also described as homogamous or protogynous. The stalk of the spadix remains short and straight and does not curl up spirally. Pollination is no doubt again effected by floating pollen, but no direct observations have been made.

967. Zannichellia Mich.

Flowers monoecious and hydrophilous. The pollen-grains possess no extine.

2958. Z. palustris L. (Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, pp. 130–2; Roze, J. Bot., Paris, i, 1887, pp. 296–9.)—Tritzschke states that the pollen-grains possess no extine, hence it is highly probable that the species is hydrophilous. The male flower consists of one exposed stamen, the female of a cup-shaped involucre with four carpels, possessing short styles, and stigmas uniting to form a crooked funnel. As long as the pollen-grains remain in the closed anthers they are spheroidal in shape, but as soon as they leave those receptacles they become tubes which force their way to the stigmas. Each of the latter is a triangular, rather large lobe; Roze says that three or four such lobes meet, forming a funnel to catch the floating pollen.

968. Zostera L.

Flowers monoecious and hydrophilous. The pollen-grains possess no extine.

2959. Z. marina L. (Clavaud, 'Fécond. du Zostera'; A. Engler, Bot. Ztg., Leipzig, xxxvii, 1879, pp. 654–5; H. Schenck, op. cit., p. 127; Delpino, 'Ult. oss.,' II.)—The numerous unisexual flowers of this species possess no perianth; they are sessile on a membranous foliar axis, and surrounded by an involucre, which is produced into a linear expansion. The flowers are arranged on the axis as single anthers and ovaries in two longitudinal rows, the male flowers alternating with the female ones above and at the side. This position also makes it possible that each two adjacent anthers and ovaries together form a hermaphrodite flower. The inflorescences are protogynous. In the first stage, the two filiform furcate stigmas project 3 mm. from the involucre, while the anthers are still closed. The anthers then suddenly dehisce and shed all their pollen-grains simultaneously. These possess no extine, and form thread-shaped clumps which float about on the surface of the water, and are caught by the stigmas of plants still in the first (female) stage. The stigmatic branches are made up of wedge-shaped, outwardly curved cells, which become soft at the spot where a pollen-grain adheres and render it possible for the pollen-tube, hitherto a short, blunt process, to penetrate. When pollination has been effected the styles fall off.

2960. Z. nana Roth. (Knuth, 'Bl. u. Insekt. a. d. nordfr. Ins.,' p. 138.)—The flower mechanism of this species no doubt agrees with that of the preceding one, but hitherto I have never been able to find it in flower, although I have examined an extremely large number of plants, particularly near the Halligen. The species there propagates very abundantly in a vegetative manner.

969. Posidonia Kon.

The flowers of species belonging to this genus are protogynous. (Delpino, 'Ult. oss.,' II, pp. 6–7.)

CXXIV. ORDER *CYPERACEAE* JUSS.

(Numerous memoirs by Appel must be added to the bibliography for this order.)

All the species of this order are anemophilous. In all species so far examined cross-pollination by protogyny, more rarely by protandry or dioecism, is favoured.

The Danish species of Cyperaceae examined by Raunkjær (Bot. Tids., Kjöbenhavn, xviii, 1893, pp. 19–23) are all protogynous, though to different degrees. He mentions the following species:—Carex digitata *L.*, C. caespitosa *L.*, C. stricta *Good.*, C. montana *L.*, C. pilulifera *L.*, C. remota *L.*, C. cyperoides *Murr.*, C. axillaris *Good.* (= C. Boenninghauseniana *Weihe*), C. paniculata *L.*, C. paradoxa *Willd.*, C. teretiuscula *Good.*, C. vulpina *L.*, C. muricata *L.*, C. elongata *L.*, C. pallescens *L.*, C. flava *L.*, C. sylvatica *Huds.*, C. distans *L.*, C. fulva *Good.*, C. chordorrhiza *L.*, C. arenaria *L.*, C. disticha *Huds.*, C. incurva *Lightf.*, C. dioica *L.*, C. vulgaris *Fries* (= C. Goodenowii *J. Gay*), C. gracilis *R. Br.*, C. praecox *Jacq.* (= C. verna *Vill.*), C. ericetorum *Poll.*, C. panicea *L.*, C. flacca, C. limosa *L.*, C. rostrata *L.*, C. vesicaria *L.*, C. paludosa *Good.* (= C. acutiformis *Ehrh.*), C. riparia *Curt.*, C. filiformis *L.*, C. hirta *L.*, Rynchospora fusca *Ait.*, Cladium germanicum *Schrad.* (= C. Mariscus *R. Br.*), Eriophorum polystachion *L.*, E. angustifolium *Roth* (= E. gracile *Sm.*), E. vaginatum *L.*, Scirpus sylvaticus *L.*, S. pauciflorus *Lightf.*, and others.

I can confirm Raunkjær's statements with regard to the species of this order native to Schleswig-Holstein. Those collected in this province which I have in my herbarium are all more or less protogynous. This applies to the flowers of the hermaphrodite and the inflorescences of the monoecious species. They are the following:—

Pycreus flavescens *Beand.* (= Cyperus flavescens *L.*), Cyperus fuscus *L.*, Cladium germanicum *Schrad.* (= C. Mariscus *L.*), Rynchospora alba *Vahl*, Eleocharis palustris *R. Br.*, E. multicaulis *Sm.*, E. acicularis *R. Br.*, Scirpus caespitosus *L.*, S. pauciflorus *Lightf.*, S. nanus *Spreng.*, S. fluitans *L.*, S. setaceus *L.*, S. lacustris *L.*, S. triqueter *L.*, S. pungens *Vahl*, S. maritimus *L.*, S. sylvaticus *L.*, S. radicans *Schkuhr*, S. Caricis *Retz.*, S. rufus *Schrad.* Eriophorum alpinum *L.*, E. vaginatum *L.*, E. angustifolium *Roth*, E. latifolium *Hoppe*, E. gracile *Koch.* Carex dioica *L.*, C. pulicaris *L.*, C. arenaria *L.* (= C. ligerica *J. Gay*), C. disticha *Huds.*, C. muricata *L.* (= C. virens *Lam.*), C. vulpina *L.*, C. paniculata *L.*, C. teretiuscula *Good.*, C. paradoxa *Willd.*, C. Schreberi *Schrank*, C. remota *L.*, C. echinata *Murr.* (= C. stellulata *Good.*), C. leporina *L.*, C. elongata *L.*, C. canescens *L.*, C. stricta *Good.*,

C. caespitosa *L.*, C. acuta *L.*, C. vulgaris *Fries* (= G. Goodenowii *J. Gay*), C. Buxbaumii *Wahlenb.*, C. limosa *L.*, C. pilulifera *L.*, C. praecox *Jacq.*, C. ericetorum *Poll.*, C. montana *L.*, C. panicea *L.*, C. glauca *Scop.*, C. sylvatica *Huds.*, C. strigosa *Huds.*, C. pendula *Huds.*, C. pallescens *L.*, C. digitata *L.*, C. flava *L.*, C. Oederi *Retz.*, C. extensa *Good.*, C. Hornschuchiana *Hoppe*, C. fulva *Good.*, C. distans *L.*, C. ampullacea *Good.*, C. hirta *L.*, C. filiformis *L.*, C. Pseudo-cyperus *L.*, C. vesicaria *L.*, C. paludosa *Good.*, C. riparia *Curt.*

Kerner states that all monoecious species are protogynous.

Hermann Müller ('Weit. Beob.,' I, p. 293) describes Scirpus lacustris *L.*, S. maritimus *L.*, and Eriophorum angustifolium *Roth* as protogynous.

Kirchner ('Neue Beob.,' p. 10) says that Carex brizoides *L.* and C. praecox *Jacq.* (= C. verna *Chaix et Vill.*) are feebly protogynous.

Axell describes the following as protogynous:—Scirpus lacustris *L.*, S. maritimus *L.*, Carex pallescens *L.*, C. Oederi *Retz.*, C. panicea *L.*, C. atrata *L.*, C. alpina *L.*, C. aquatilis *Wahlenb.*, C. vulgaris *Fries* (= C. Goodenowii *J. Gay*), C. vaginata *Tausch*, and other species of Carex; Eriophorum alpinum, E. angustifolium *Roth*, E. latifolium *Hoppe*, and E. Scheuchzeri *Hoppe*. (Most of these species have already been mentioned.)

Kirchner also describes all German species of Eriophorum as protogynous, and MacLeod all species of Eleocharis.

Appel arrived at somewhat different results. At Schaffhausen he not infrequently observed for several years protandrous plants mixed with numerous protogynous stocks of Carex montana *L.* and C. praecox *Jacq.* He was able to confirm this observation lately on Carex digitata *L.* and C. humilis *Leyss.*, also in the neighbourhood of Wurzburg.

While, however, in the latter district the carices of the woods and meadows were always predominantly protogynous, the marsh and water species were almost entirely homogamous to protandrous; Warnstorf confirms this statement, at least with reference to C. caespitosa *L.* and C. vulgaris *Fries* (= C. Goodenowii *J. Gay*).

The distribution of sexes is particularly multifarious in the genus Carex, and is subject to variation. Appel speaks as follows on the subject:—

It is usual to divide the Carices into three groups—Monostachyae, Homostachyae, and Heterostachyae. This division is not a natural one if consistently carried out, as there are species which are not easily classified, and have therefore been inconsistently placed, as is the case, e. g. with C. Buxbaumii *Wahlenb.* Besides this the system does not always take into account the natural relation of larger groups, as may be plainly seen in the division of Monostachyae, which is made up of entirely different elements.

In Monostachyae are included the species bearing a single terminal spikelet. This may either combine both sexes, e. g. in C. pulicaris *L.*, or may be unisexual, so that the plant is dioecious, as, e. g. in C. dioica *L.* In these dioecious species, however, it is not unusual to find individual plants uniting both sexes arranged alternately in one spikelet, and sometimes, though rarely, others in which there are small lateral spikelets in addition to the chief one. In the monoecious species, on the contrary, individuals now and then occur with exclusively male or female spikelets.

In the group of Homostachyae are included those species possessing several

spikelets, in which, however, both sexes are arranged variously; it is divided into three groups, e.g. Acrarrhenae, in which all the spikelets are male at the tip and female at the base; Hyparrhenae, with male spikelets at the base and female at the tip; and Holarrhenae, in which the middle spikelets are male, while the terminal and basal ones are female.

Here also we find a great tendency to variation, particularly in the last group with its species of C. disticha *Huds.*, C. arenaria *L.*, and C. pseudo-arenaria. The division of the sexes is not only found in quite different parts of the spikelet, in which first one then the other sex predominates; but the relative position of the sexes may also vary.

Finally the group of Heterostachyae includes those species which typically possess one or several terminal male spikelets and several lateral female spikelets. C. Buxbaumii *Wahlenb.* is also reckoned in this group, as it bears female flowers at the tip of the male spikelet. This arrangement is, however, not infrequently found in other species also, e.g. in C. glauca *Scop.* But the reverse, i.e. terminal spikelets which are female at the base, are not rare. The female spikelets very frequently contain a number of male flowers, sometimes at the tip (especially frequent in C. glauca *Scop.*, and sometimes at the base, as in C. vulgaris *Fries*, or distributed over the whole spikelet.

Compound spikelets are also not rare, and are particularly frequent in C. sylvatica *Huds.* and C. glauca *Scop.*

The number of stigmas, which is also considered in systematics, is not quite constant. In species normally bearing three stigmas flowers are not infrequently found bearing only two, e.g. C. paludosa *Good.* and C. glauca *Scop.*; on the other hand, though more rarely, styles with three stigmas (e.g. in C. acuta *L.*) are found in spikelets of species with two stigmas.

Speaking generally, therefore, the distribution of sexes in the genus Carex is on the one hand very numerous, but on the other hand very variable.

A fact connected with the process of fertilization, but not yet satisfactorily explained, may also be mentioned. Completely or partially sterile axes and stocks are often found, which are not hybrids. I observed this to be particularly striking in C. glauca *Scop.* at Winterthur, C. vesicaria *L.* in the Binninger Rind (South Baden), C. panicea *L.* at Würzburg, and other species in a more or less marked degree. The assumption seems justified that such occurrences may be explained by the absence of fertilization in consequence of unfavourable weather in species dependent on dryness and wind for pollination.

Andersson and Hesselman ('Bidrag till Känned. om Spetsbergens o. Beeren Eil. Kärlväxtflora,' pp. 77–82) observed the flowering and fruiting times of the following species in Spitzbergen.—Carex saxatilis *L.*, C. misandra *R. Br.*, C. salina *Wahlenb.* var. *subspathacea* Drej., C. vulgaris *Fries* (= C. rigida *Good.*), C. ursina *Dewey*, C. lagopina *Wahlenb.*, C. glareosa *Schkuhr*, C. incurva *Lightf.*, C. dioica *L.* var. *parallela* Laest., C. nardina *Fries*, C. rupestris *All.*, Eriophorum angustifolium *Roth* var. *β. triste* Fries, E. Scheuchzeri *Hoppe.*

Vanhöffen (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' pp. 85–95) observed the following species flowering and mostly fruiting in Greenland during June to August.—Eriophorum Scheuchzeri *Hoppe*, E. polystachion *L.*, Kobresia caricina *Willd.*, Carex nardina *Fries*, C. capitata *L.*, C. scirpoidea *Michx.*, C. microglochin *Wahlenb.*, C. rupestris *All.*, C. incurva *Lightf.*, C. glareosa *Schkuhr*, C. bicolor *All.*,

C. alpina *Sw.* C. ustulata *Wahlenb.*, C. misandra *R. Br.*, C. salina *Wahlenb.* (= C. hyperborea *Drej.*), C. vulgaris *Fries* (= C. rigida *Good.*), C. capillaris *L.*, C. rariflora *Sm.*, C. pedata *L.*, C. saxatilis *L.* (= C. pulla *Good*).

The species of this order also receive occasional visits from pollen-devouring or pollen-collecting insects, which sometimes effect crossing.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Herm. Müller ('Fertilisation,' p. 567, 'Weit. Beob.,' I, p. 293), the hover-fly Melanostoma mellina *L.*, po-dvg., on the spikelets of Eleocharis palustris *R. Br.* (= Scirpus palustris *L.*), and the honey-bee, po-cltg., on Carex hirta *L.* and C. montana *L.* Kirchner ('Neue Beob.,' p. 10), the honey-bee, po-cltg., on Carex praecox *Jacq.* (= C. verna *Vill.*). Loew (Berlin Botanic Garden), the beetle Cantharis fusca *L.*, dvg. the anthers of C. Fraseri *Andr.* Appel (Schweinfurt), numerous beetles, busily po-dvg., on the ♂ spikelets of Carex acuta *L.* and C. vulgaris *Fries* (= C. Goodenowii *J. Gay*). The same author states that many species of Cyperaceae, and particularly of the genus Cyperus, e. g. Carex baldensis *L.*, are adapted by their brightly coloured, closely crowded inflorescences to attract insects.

Some special examples will illustrate these general remarks.

970. Cyperus L.

2961. C. fuscus L.—The flowers of this species are protogynous; but sometimes the stigmas are still receptive when the pollen of the same flower is mature, and autogamy is thus possible. As a rule when the flower is in the female stage, the two mature anthers of the one next below it on the spikelet project on stiff filaments a little above the bracts so that geitonogamy can easily take place. The species is never anemophilous. The pollen-grains are white in colour, four-sided pyramidal, the surface of the base arched, feebly tuberculate, up to 30 μ long.

971. Rynchospora Vahl.

2962. R. fusca Ait.—The flowers of this species are protogynous; the pollen-grains are pale-yellow in colour, irregular, very variable in size, tetrahedral or three-sided pyramidal, the surface of the base arched to a hemispherical curve or less, and the tip bluntly rounded, closely papillose, up to 43 μ long and 31 μ broad (Warnstorf).

972. Scirpus L.

2963. S. caespitosus L.—Schröder (Bot. Jahrb., Leipzig, xi, 1890, p. 513) says that in this species male and female stocks occur besides those bearing only hermaphrodite flowers. Raunkjær also states that the plant shows a tendency to gynodioecism.

2964. S. supinus L. (MacLeod, Bot. Jaarb. Dodonaea, Ghent, i, 1889, p. 513.)—This species was observed by Jackson with underground cleistogamous flowers.

2965. S. lacustris L.—This species is markedly protogynous. When the pollen is mature the stigmas of the same flower are already brown and shrivelled, so that self-pollination is excluded. As the flowers of individual plants, however, open very irregularly, specimens may be found during anthesis with flowers in the ♀ (first)

stage and others in the ♂ (second) stage at the same time; this brings about dioecism, so that cross-pollination by means of wind can take place very frequently. Besides this, however, small staphylinid beetles, which I frequently found thickly dusted with pollen in the spikelets, seemed to effect cross-pollination. The pollen-grains are pale-yellowish in colour, irregularly tetrahedral to bluntly-triangulo-pyramidal, about 37·5 to 43·7 μ broad and 62·5 μ long.

In addition to normal flowers with three stigmas, others with two sometimes occur.

2966. S. Caricis Retz. (= S. compressus *Pers.*).—In this species the pollen-grains are pale-yellowish in colour, rounded tetrahedral, feebly papillose, 37·5 to 44 μ in diameter.

2967. S. sylvaticus L.—This species is strongly protogynous, with persistent stigmas. The stamens do not mature until some days later than the latter. The pollen-grains are yellowish in colour, tetrahedral with small tubercles, about 91 μ in diameter.

973. Eriophorum L.

2968. E. polystachion L.—This species is protogynous. The flowers are hermaphrodite or purely female; specimens with only female ones are often found in sheltered stations. The style of the female flower, bearing 3 long stigmatic branches closely beset with papillae, projects far beyond the bracts. The pollen-grains are sulphur-yellow in colour in the mass, tetrahedral, tuberculate, on an average 37–40 μ in diameter (Warnstorf).

I. M. Normann (Bot. Not., Lund, 1868, p. 13) states that in the north of Norway this species is sometimes hermaphrodite and dioecious.

2969. E. vaginatum L.—Raunkjær says that this species is sometimes completely gynodioecious.

974. Kobresia Willd.

Pax describes the spikes as consisting of some two-flowered spikelets, in which the terminal one is male and the lateral female.

975. Carex L.

2970. C. dioica L., and **2971. C. Davalliana** Sm.—In these species individuals bearing single or more numerous female flowers, at the base or in the middle of the male spikes, are not rare.

2972. C. baldensis L.—The yellowish-white, capitate inflorescences in this species, formed by the grouping together of the spikelets, are extraordinarily conspicuous, and undoubtedly attract insects, which effect crossing. At Riva, Appel observed gnats, and a few small beetles. The size of the inflorescence varies greatly, and its conspicuousness is affected by the presence or absence of the largest part of last year's dark-green foliage during anthesis. Appel observed that these conditions varied according to the altitude in the neighbourhood of Lake Garda.

2973. C. paradoxa Willd.—This species is sometimes purely male; such stocks, since their spikelets in later stages are devoid of fruits, have not infrequently occasioned crosses with the hybrids of C. paradoxa *Willd.*, C. teretiuscula *Good.*, and C. paradoxa *Willd.* or C. paniculata *L.* Appel says that large sods are often found, of which the inner spikelets are normal composed, but surrounded by a belt of male stems, so that the female flowers are pollinated in whatever direction the wind may be.

Warnstorf describes the pollen-grains as pale-yellowish-white in colour, tetrahedral, tuberculate, on an average from 37 μ in diameter.

2974. C. Schreberi Schrank (= C. praecox *Schreb.*).—Warnstorf describes the pollen-grains in this species as yellowish in colour, spheroidal-tetrahedral, closely beset with small tubercles, about 30 μ in diameter.

2975. C. leporina L.—Appel not infrequently observed pollen-collecting insects, especially flies, on the spikelets of this species, which indicates the possibility of entomophily. The varieties argyroglochin *Hornem.*, with its straw-yellow, and atrofusca *Christ*, with its dark-brown, almost blackish spikes, may also be of oecological significance.

2976. C. vulgaris Fries (= C. Goodenowii *J. Gay*), and **2977. C. stricta** Good.—In these species purely male stems occur not infrequently, or spikelets with female flowers becoming male at the tip.

The pollen-grains are pale-yellow in colour, tetrahedral, with rounded corners, delicately tuberculate, from 37–43 μ in diameter. (Loew, 'Blütenbiol. Floristik,' p. 364.)

2978. C. praecox Jacq. (= C. verna *Vill.*).—This species, besides C. glauca *Scop.*, is probably one of those in which variations in the position of the spikelets most frequently occur. From the variety *gynobasis* Spenn., which bears a basal spikelet on a long, slender stalk, there are all transitions to the type in which one terminal male spikelet is present with one to three female ones close below it.

The pollen-grains are sulphur-yellow in colour, markedly conical to pear-shaped, tuberculate, about 37 μ long and 30 μ broad.

2979. C. montana L.—In addition to the most usual form of this species with red-brown spikelets, one with straw-yellow male ones is also frequently found.

2980. C. digitata L.—The pollen-grains in this species are sulphur-yellow in colour, tetrahedral, tuberculate, 30–7 μ in diameter (Warnstorf).

2981. C. glauca Murr.—This is one of the most variable German species. Besides the normal female flowers with three stigmas, others with two occur fairly frequently. Appel says that the following forms are also found:—

(1) A single terminal male or female spikelet;

(2) A basal long-stalked female spikelet, otherwise normal;

(3) All female spikelets with short stalks and distributed over the upper two-thirds of the stem;

(4) Female spikelets with long stalks, hanging over when the fruit ripens, and inserted more or less widely apart;

(5) Female spikes are either all, or the terminal one only, male at the tip;

(6) Female spikelets provided at the base with lateral spikelets, which may be either purely female, or else male at the tip.

2982. C. panicea L.—This species is homogamous; the pollen-grains are pale-yellow in colour, tetrahedral, smooth, about 37 μ in diameter. Warnstorf observed the following variations in the inflorescences of this species at Ruppin:—

(1) Two or three female spikes are crowded closely together immediately below the terminal male spike, and one female spike is situated about 3·5 cm. deeper.

(2) One thick, ovoid, crowded female spike is situated at the tip of the stem, and one purely male or partly female on one slightly lower;

(3) One ovoid, crowded female spike is situated below the terminal male spike.

Warnstorf also saw a very robust variety, 40–50 cm. high, around and in moor-pools not far from Lindow. It bore one very dense clavate terminal male spikelet, and several normal female spikes. The plant gives the impression of being quite foreign by the form of the male spikes and the breadth of the leaves.

2983. C. sylvatica Huds.—This species frequently occurs with compound spikelets.

2984. C. Pseudo-cyperus L.—In this species also numerous variations in the distribution of the sexes are found, and Appel in particular often observed spikelets which were male at the base and female at the tip.

CXXV. ORDER *GRAMINEAE* JUSS.

Cf. Körnicke, 'D. Arten u. Varietäten d. Getreides,' 1885, a memoir omitted from the bibliography.

All species of this order are distinctly anemophilous. The flowers of grasses are, as De Candolle observed, ephemeral, opening only once; this usually takes place in the morning during favourable weather. The opening of the flowers, caused by the divergence of the glumes, is effected by the two lodicules, according to Hackel (Bot. Ztg., Leipzig, xxxviii, 1880, pp. 432–7). These become fleshy and succulent, and usually spheroidally swollen at the base, by which means they overcome the resistance of the elastic outer glume and move it outwards. After fading, which occurs at the latest in 1–2 hours, the lodicules shrivel up again into small thin leaves, thus bringing the outer glume once more into its former position. This is particularly plain in Arrhenatherum elatius *Mert. et Koch.* Turgidity increases very quickly as the flower opens, and may therefore be traced to the absorption of water; a pin-prick actually causes a small drop to exude.

Rimpau (Landw. Jahrb., Berlin, xii, 1883, pp. 875–919) has carefully investigated the flowering of cereals. He confirms the fact first pointed out by Hackel, that the opening of the glumes is affected by the swelling of the lodicules. The rapid growth of the filaments on the opening of the flowers in many species, first observed by Askenasy, is also confirmed by Rimpau.

Hackel ('Gramineae,' in Engler u. Prantl's 'D. nat. Pflanzenfam.,' II, 2) states that grasses are usually protandrous, more rarely protogynous (Alopecurus, Antho-

xanthum, Pennisetum, and Spartina). The anthers empty most of the pollen at once by turning completely over. When the stigmas project laterally from the pendulous or nodding spikelet, they bend upwards and are thus only dusted with the pollen of flowers situated above. Rarely they project from the tip of the spikelet; this occurs in protogynous and monoecious species. Cleistogamy is not infrequently found, according to Kieffer, e. g. in Leersia oryzoides *Sw.*, Festuca Myuros *L.*, F. bromoides *L.*, F. ciliata *Pers.*, and others (Bul. soc. bot., Lyon, viii, 1890).

This process is not seen in other genera. The glumes in species of Alopecurus, Anthoxanthum, Mimbora (verna), Crypsis, Nardus (stricta), Phalaris, and Phleum, open scarcely or not at all during anthesis. In these cases stigma and anthers project outwards through a narrow slit. Phleum and Phalaris possess vestigial lodicules; in the other genera named they are quite absent.

Ludwig (Bot. Centralbl., Cassel, viii, 1881, p. 87) says that the succulent, shining lodicules of many grasses, serving as expanding bodies, sometimes seem to attract flies, which are imprisoned by the rapid closing of the glumes. He repeatedly observed flies imprisoned in this var., and already partly destroyed, on Molinia caerulea *Moench*; these had all been caught by the proboscis, which was firmly gripped by the glumes below the lodicules.

Ludwig (Bot. Centralbl., Cassel, xviii, 1884, p. 123) subsequently found his supposition only partially confirmed. At Greiz he observed thousands of hover-flies (sp. of Melithreptus, Melanostoma, Platycheirus) on Molinia caerulea *Moench*, most of them dead and swollen out of shape, some still living, but suffering from the Entomophthora disease. On the flowers (with blue anthers) of Phleum pratense *L.*, Avena pubescens *Huds.*, Dactylis glomerata *L.* (and Plantago lanceolata), there were also flies suffering from this fungoid disease, but much more rarely than on Molinia. A large number were adhering to the flowers (many being fastened to the anthers in Molinia), but still more were trapped in the manner described above. The flies observed earlier seemed to be quite free from fungus. In the cases noticed later it may have been the result of the fungoid disease that the Molinia was so closely covered with flies. Their frequent adherence gave the impression that they had been compelled by thirst to seek the juice of the lodicules, and overtaken by death while sucking it, the proboscis being then fastened in later as the outer glume closed.

Sprengel ('Entd. Geh.,' pp. 26, 79–80) evidently also observed the lodicules, as he speaks of the 'nectar-glands' of the grasses; the apparent presence of nectar in flowers of grasses, which otherwise possess all the distinguishing marks of anemophily, was a problem which he could not solve.

Many grasses are protogynous, so that self-pollination is frequently prevented; automatic self-pollination does, however, often take place, and cleistogamous flowers are also tolerably frequent (e. g. in Oryza, Stipa, Bromus, Hordeum, Cryptostachys, and others.

Kiefer states that Festuca Myuros *L.*, F. bromoides *L.*, and F. ciliata *Pers.* bear cleistogamous flowers.

Andersson and Hesselman ('Bidrag till Känned. om Spetsbergens o. Beerens Eil. Kärlväxtflora,' pp. 70–8) have determined more or less accurately the flowering and fruiting seasons of the following species:—Festuca rubra *L.* var. arenaria *Osb.* F. ovina *L.* vars. violacea *Nath.* and vivipara *L.*, Glyceria angustata *T. Fries*

G. vilfoidea *T. Fries*, G. Vahliana *T. Fries*, G. Kjellmanni *Lange*, Phippsia algida *R. Br.* (= Catabrosa algida *Fries*), Catabrosa carcinna *T. Fries*, Colpodium latifolium *R. Br.*, Arctophila Malmgreni *And.*, Graphephorum psilosanthum *Fourn.* (= Dupontia Fischeri *R. Br.*), Trisetum subspicatum *Beauv.*, Deschampsia caespitosa *Beauv.* (= Aira caespitosa *L.*) var. borealis *Trautw.*, D. alpina *Roem. et Schult.* (= Aira alpina *L.*), Calamagrostis stricta *Hartm.*, Alopecurus alpinus *Sm.*, Hierochloë alpina *Roem. et Schult.*

Vanhöffen (Abromeit, 'Bot. Ergeb. von Drygalski's Grönlandsexped.,' pp. 95–105) observed the following in Greenland from June to August, flowering and mostly fruiting.—Elymus arenarius *L.* vars. β. villosus *E. Mey.* and γ. compositus *nov. var.*, Alopecurus alpinus *Sm.*, A. geniculatus *L.* (= A. fulvus *Sm.*), Hierochloë alpina *Roem. et Schult.*, Agrostis rubra *L.*, Deyexxia sylvatica *Kunth* (= Calamagrostis purpurascens *R. Br.*), Calamagrostis stricta *Hartm.* var. β. borealis *Laestad.*, Trisetum subspicatum *Beauv.*, Colpodium latifolium *R. Br.*, Glyceria Borreri *Bab.* (perhaps introduced), G. vaginata *Lange*, G. maritima *Mert. et Koch*, G. vilfoidea *T. Fries*, Poa abbreviata *R. Br.*, P. alpina *L.*, P. pratensis *L.*, P. flexuosa *Muhl.*, Festuca ovina *L.* subsp. borealis *Lange* and vars. β. tenuifolia *Lange* (?) and γ. alpina *Koch*, F. rubra *L.* var. β. arenaria *Rink.*

Visitors.—Insect-visits to the flowering grasses may be occasionally observed, as already stated. The hover-fly Melanostoma mellina *L.*, especially, is fond of seeking out Molinia caerulea *Moench*, and other anemophilous flowers, in order to devour their pollen.

The secretion of the fluid so eagerly sought by flies may be undoubtedly traced to Sphacelia segetum, the conidial stage of Claviceps purpurea, which forms the so-called 'ergots' on cereals and other grasses. Fly visitors convey this disease to healthy stocks of Ammophila in flying from one plant to another. It is perhaps also possible that Sprengel was misled into the opinion quoted above by the presence of this so-called 'honey-dew' in the flowers of grasses examined by him.

The following were recorded by the observers, and for the localities stated.—

Knuth (Kiel and the North Frisian Isl., 'Blütenbesucher,' I, p. 9), several individuals of the hover-fly Melanostoma mellina *L.*, on Alopecurus pratensis *L.*, Phleum pratense *L.*, and Anthoxanthum odoratum *L.*: (dunes of Helgoland)—a beetle (Psilothrix cyaneus *Oliv.*), a hover-fly (Syrphus arcuatus *Fall.*, freq., po-dvg.), and 5 Muscids—1. Calliphora erythrocephala *Mg.*, very freq., po-dvg. and licking up a sweetish fluid present on the spikes; 2. C. vomitoria *L.* (?), do.; 3. Lucilia caesar *L.*, do.; 4. Coelopa frigida *Fall.*, in great numbers, po-dvg.; 5. Fucellia fucorum *Fall.*, do. Von Fricken (Arnsberg), the Phalacrid beetle Phalacrus corruscus *Payk.* MacLeod (Ghent), on Secale cereale *L.* and Agropyrum repens *Beauv.*, the Muscid Spilogaster duplicata *Mg.*, very freq., po-dvg. Herm. Müller (Westphalia, 'Fertilisation,' p. 568, 'Weit. Beob.,' I, p. 292), the hover-fly Melanostoma mellina *L.* on Alopecurus pratensis *L.*, Phleum pratense *L.*, Anthoxanthum odoratum *L.*, and (Fichtelgebirge) Agrostis alba *L.*; (Westphalia, 'Weit. Beob.,' I, p. 292), on Bromus mollis *L.*, 4 or 5 individuals of the beetle Leptura livida *F.*: after flying in long curves, as it often does before settling on a flower, this insect settled on a flowering spike from which the yellow stamens hung out, crept rapidly above the inflorescence, moving its jaws, but taking no notice of the anthers; after visiting almost all the spikelets it flew away to another plant and repeated the performance: (Thuringia, loc. cit.), the beetle Malachius viridis *F.*, Brachypodium pinnatum *Beauv.*, obviously attracted by the golden yellow anthers, and dvg. both anthers and pollen.

976. Zea L.

2985. Z. Mays L. (*Cf.* G. Krafft, 'D. norm. u. anorm. Metamorph. d. Maispfl.,' 1870.)—Hildebrand ('Bestäubungsverh. d. Gramineen') says that the terminal male panicle of this species has already dehisced when the stigmas of the lateral female spikes diverge; Kerner ('Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 313) describes the species as protogynous. I can confirm Hildebrand's statements from observations of cultivated plants in the Oberrealschule Garden in Kiel.

Warnstorf describes the maize as protandrous to homogamous. The anthers dehisce apically only by a short, lateral slit. The pollen-grains are sulphur-yellow in colour, resembling a short, blunt pyramid with a rounded base, very large, up to 100 μ long and 70 μ broad. Female flowers are not infrequently found in the male panicle, and male spikelets in the female spike.

Kirchner ('Flora v. Stuttgart,' p. 115) states that the dehiscence of the anthers continues until the stigmas mature, so that crossing is favoured at first, and geitonogamy may take place later.

Hildebrand ('D. Geschlechts-Vert. b. d. Pfl.,' p. 10) says that single female flowers sometimes occur on the male inflorescences, more frequently the female inflorescences end in a male spike. Penzig ('Studi morfol.,' I) gives a similar account; he often observed female spikelets in the male panicle and male spikelets in the female spikes, besides hermaphrodite flowers and stamens transformed into carpels. Krafft (op. cit.) describes a number of such variations.

The plants cultivated in gardens in Kiel are markedly protandrous, the male flowers arranged in terminal panicles dehiscing before the stigmas of female flowers on the same plant protrude, but (perhaps only in very sheltered stations) enough pollen-grains remaining over to fertilize the later projecting stigmas of the same plant by fall of pollen. This is proved by the fact that a single plant which grew up spontaneously in my garden set abundant fertile fruits, although no other maize-plant grew for a considerable distance round. The species is therefore self-fertile, but only imperfectly so, perhaps from scarcity of pollen; each of the two female spikes of the plant contained about 630 ovules, of which in the older one only 103 (16 %) and in the younger only 25 (4 %) fertile fruits were set. The male flowers possess (like many grasses) an odour of cumarin; the female ones are odourless (Knuth, 'Blütenbiol. Notizen').

977. Andropogon L.

2986. A. Ischaemum L. (Kirchner, 'Beiträge,' p. 71.)—In plants of this species growing in the Hohenheim Botanic Garden there are always two spikelets, each consisting of one flower, which are situated together at the same level on the spicate part of the inflorescence, of which one is sessile and hermaphrodite and the other stalked and male. All the sessile (hermaphrodite) spikelets on the inflorescences now mature simultaneously, and after they have faded all the stalked (male) spikelets, again simultaneously. The whole inflorescence is therefore hermaphrodite at first, and purely male later. The hermaphrodite flowers are homogamous; their dark-red stigmas are in the form of a cylindrical brush. All the anthers are black-red and attached to thin, limp filaments.

978. Panicum L.

2987. P. sanguinale L. (= Digitaria sanguinalis *Scop.*). (Hildebrand, 'Bestäubungsverh. d. Gramineen,' p. 757.)—In this species self-pollination only is possible at first, in consequence of the simultaneous protrusion of stigma and anthers, but crossing may be effected when the anthers have fallen, as the stigmas are persistent.

2988. P. Crus-galli L.—Hildebrand (op. cit.) says that this species agrees with the preceding one.

2989. P. miliaceum L. (Kirchner, 'Flora v. Stuttgart,' p. 119.)—The flowers of this species are homogamous. Stigmas and anthers protrude simultaneously from their fairly wide entrance. The anthers dehisce along their entire length. Although the filaments are rather thin, the stamens are not pendulous, but approach the stigmas when the glumes close. Crossing is therefore favoured at first, and automatic self-pollination possible later.

979. Setaria Beauv.

2990. S. italica Beauv.—This species, according to Kirchner ('Flora v. Stuttgart,' p. 119), possesses the same flower mechanism as Panicum miliaceum.

980. Phalaris L.

2991. P. arundinacea L. (= Digraphis arundinacea *Trin.*). (Hildebrand, op. cit., p. 756.)—In this species the stigmas, which project a little from the glumes, can at first be dusted by the pollen of older flowers only, then by their own, and finally by that of younger ones. Warnstorf (Verh. bot. Ver., Berlin, xxxviii, 1896) says that the flowers are feebly protogynous to homogamous; the anthers are dirty-reddish in colour, and their filaments still stiff when they dehisce; pollen is scattered during the morning. The pollen-grains are white in colour, irregular, resembling a blunt, usually five-sided pyramid with a rounded base, up to 43 μ long and 25–31 μ broad.

2992. P. canariensis L. (Hildebrand, op. cit.; Körnicke, op. cit.; Kirchner, 'Flora v. Stuttgart,' p. 121.)—When the flowers of this species open the outer glume spreads out, but the inner ones only open widely enough for anthers and stigmas to force their way between them. In doing so the anthers often protrude on the side turned away from the axis, but the stigmas on that facing it, so that self-pollination is then prevented. The filaments either remain erect or tip over, and in the latter case the anthers partly dehisce before and partly after this upsetting. Crossing is therefore favoured at some times and self-pollination at others, while the latter is sometimes inevitable. It may also happen that the anthers do not project between the glumes at all, but that their dehisced tips protrude, while the rest of them remains entirely concealed. Körnicke states that the flowers open between 12 to 4, but Hildebrand only observed this to take place towards evening. It never seems to occur in the morning.

981. Pennisetum Rich.

2993. P. spicatum Körn.—Körnicke describes the pollination of the species as follows:—the inflorescence matures from the middle outwards (not above the

middle), sometimes a little irregularly. The glumes remain closed; the stigmas push slowly forward on the tips of the latter, the stamens forcing their way out of the tips of the hermaphrodite flowers (before and not after midday, apparently), only when all the stigmas of the same inflorescence are faded. The filaments are long and stiff (as in Dactylis glomerata *L.*, with widely opened flowers), and the anthers dehisce along their whole length. The stamens of the male flowers do not elongate until later. This species therefore belongs to the protogynous grasses, and cross-pollination always takes place. In warm climates, however, the whole process is probably effected more quickly than with us.

982. Hierochloë S. G. Gmel.

2994. H. odorata L. (Hildebrand, op. cit.)—This species is andromonoecious. In the two-flowered spikelet the lower flower is male and the upper one hermaphrodite.

983. Anthoxanthum L.

2995. A. odoratum L. (Axell, 'Om Anord. för Fanerog. Växt. Befrukt.'; Hildebrand, op. cit., p. 745; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 297; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 312; Kirchner, 'Flora v. Stuttgart,' p. 122.)—Axell describes the flowers of this species as markedly protogynous, while Hildebrand states that self-pollination is excluded. The anthers of the whole inflorescence do not protrude between the glumes and dehisce until the stigmas have faded, so that only cross-pollination is possible. The anthers are usually yellow, rarely red. They dehisce, according to Kerner, between 7–8 a.m.

Warnstorf (op. cit.) describes the pollen-grains as whitish in colour, rounded, rendered opaque by small, crowded tubercles, 14 μ in diameter.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Knuth and Herm. Müller, the hover-fly Melanostoma mellina *L.* Scott-Elliot (Dumfriesshire), a Muscid ('Flora of Dumfriesshire,' p. 188).

984. Alopecurus L.

2996. A. pratensis L. (Hildebrand, op. cit., p. 745.)—This species possesses the same flower mechanism as Anthoxanthum odoratum *L.* The usually whitish, more rarely bright-grey anthers become rust-red in colour after dehiscence. Kerner says that they dehisce between 7–8 a.m. Warnstorf states that this takes place at Ruppin between 10–11 a.m.

Visitors.—Knuth observed the hover-fly Melanostoma mellina *L.*

2997. A. agrestis L.—This species, according to Kirchner ('Flora v. Stuttgart,' p. 124), possesses the same markedly protogynous flower mechanism as the preceding one.

2998. A. geniculatus L. (= A. fulvus *Sm.*). (Axell, op. cit.; Kirchner, 'Beiträge,' p. 7.)—This species is markedly protogynous.

Visitors.—MacLeod (Flanders) observed a po-dvg. beetle (Malachius sp.) (Bot. Jaarb. Dodonaea, Ghent, vi, 1894, p. 365).

985. Phleum L.

2999. P. pratense L.—Axell and Kirchner describe this species as markedly protogynous, Warnstorf as homogamous. The yellow or violet anthers dehisce about 7–8 a.m. (Kerner).

Visitors.—Ludwig observed flies, and Knuth the hover-fly Melanostoma mellina *L.*

3000. P. alpinum L.—Schröter describes this species as protogynous with impeded self-pollination.

3001. P. Michelii All.—This species is described by Schröter as protogynous.

3002. P. Boehmeri Wibel.—Kirchner ('Beiträge,' p. 8) states that this species possesses the same mechanism as the other species of this genus.

986. Leersia Soland.

3003. L. oryzoides Sw. (= Oryza clandestina *A. Br.*).—This species bears cleistogamous flowers (Walz, Bot. Ztg., Leipzig, xxii, 1864, p. 145). Duval-Jouve (Bul. soc. bot., Paris, x, 1863, pp. 194–7) says that the cleistogamous flowers occur in the lateral panicles, which remain concealed in the sheath. Ascherson states that the projecting terminal panicle frequently forms only sterile spikelets, but fertile flowers may also be present.

987. Oryza L.

3004. O. sativa L. (Körnicke, op. cit.)—In this species the panicle begins to open at the tip and appears to continue during the whole day. As the glumes open, the closed anthers on their slender filaments protrude laterally and bend outwards. Later on the filaments curve over so that the anthers become pendulous. These then dehisce, at some distance from the glumes, from top to bottom, and the dry pollen falls into the air. After the protrusion of the anthers the glumes open more widely, the stigmas project or remain between the widely divergent glumes, but are accessible to foreign pollen. Later on the exserted stigmas draw back between the glumes. They often, however, remain outside even after the closing of the latter. The species is therefore allogamous.

Roxburgh ('Fl. Indica'), in the description of his var. 2, states that the male, neuter, and female flowers are mixed with hermaphrodite ones. He also says that female flowers are present in his var. 1.

988. Agrostis L.

3005. A. rupestris All.—Schröter states that self-pollination in this species is at first impeded. Kerner says that the pollen is dehisced about 11 a.m. The other species of the genus agree with this one.

3006. A. alba L.—

Visitors.—Herm. Müller observed the hover-fly Melanostoma mellina *L.*

3007. A. vulgaris With.—Warnstorf states that the flowers of this species dehisce before noon.

989. Apera Adans.

3008. **A. Spica-venti** Beauv. (= Agrostis Spica-venti *L.*). (Godron, 'Flor. d. Graminées,' 1873.)—This species is dependent upon self-pollination, the glumes diverging widely, but the anthers being closely apposed to the feathery stigmas during anthesis. Warnstorf describes the flowers as homogamous, and says that those in the upper branches of the panicles mature first, their glumes diverging before 6 a.m., and the greenish anthers dehiscing; the stigmatic branches are vertical, and the anthers at first situated on stiff filaments, so that autogamy can easily take place.

990. Calamagrostis Adans.

In flowers of species belonging to this genus Kerner states that the pollen is scattered about 12–1 o'clock.

3009. **C. neglecta** Gaertn. Mey. et Schreb.—The flowers of this species are homogamous; they dehisce between 6–7 a.m. The pollen-grains are yellowish in colour, irregularly tetrahedral, almost glabrous, on an average 37 μ in diameter (Warnstorf).

991. Ammophila Host.

3010. **A. arundinacea** Host (= Calamagrostis arenaria *Roth*).—This species is feebly protogynous; the stigmatic branches do not protrude, and are receptive within the still closed glumes, while the undehisced anthers already project slightly from their tips. The filaments do not usually elongate until after the pollen has been shed, when they tip over, so that autogamy generally takes place. The pollen-grains are pyramidal, up to 50 μ long and 37 μ broad (Warnstorf).

3011. **A. arenaria** Link (= Psamma arenaria *Roem. et Schult.*; and A. arundinacea, according to the *Index Kewensis*).—

Visitors.—Knuth (Helgoland dunes) observed many flies.

992. Milium L.

3012. **M. effusum** L.—This species is feebly protogynous, according to Kirchner ('Neue Beob.').

993. Stipa L.

Kerner states that the species of this genus (not including Aristella) are sometimes cleistogamous. Hansgirg describes them as pseudo-cleistogamous.

3013. **S. pennata** L.—Hildebrand describes this species as homogamous, and about equally dependent upon cross- and self-pollination.

994. Phragmites Trin.

3014. **P. communis** Trin. (= Arundo Phragmites *L.*).—Deichmann says that this species is subject to cross-pollination.

995. Sesleria Scop.

3015. **S. coerulea** Arduin.—Kirchner ('Beiträge,' p. 8) describes this species as markedly protogynous.

3016. **S. argentea** Savi (= S. elongata *Host*).—Hildebrand states that this and other species are protogynous, so that self-pollination is excluded.

996. Koeleria Pers.

3017. K. cristata Pers.—Hildebrand and Kirchner describe this species as homogamous. Kirchner ('Beiträge,' p. 8) states that the stigmas protrude laterally between the divergent glumes, and the blue-black anthers are situated on stiffly vertical filaments 6 mm. long, so that automatic self-pollination can easily take place. Hildebrand says that crossing is possible later on, for the receptive stigmas still project for some time from the already closed glumes.

997. Deschampsia Beauv.

3018. D. caespitosa (= Aira caespitosa *L.*).—Kerner states that this species sheds its pollen between 5 and 6 a.m.

3019. D. flexuosa Trin. (= Aira flexuosa *L.*).—Kirchner ('Beiträge,' p. 8) describes this species as homogamous, but the flowers are still open and the stigmas receptive after the blue-black anthers have fallen. Only cross-pollination, therefore, can then take place. Kerner says that the anthers dehisce between 5 and 6 p.m.

998. Holcus L.

3020. H. lanatus L.—Hildebrand ('Bestäubungsverh. d. Gramineen') describes this species as andromonoecious. Each spikelet contains two flowers, one hermaphrodite homogamous and one male. Cross- and self-pollination are about equally favoured. Hildebrand states that the flowers open at midday; Kerner says that the flowers of this and other species of the genus may open twice on the day of flowering if the weather is favourable and the temperature 14° C., i. e. at 6 a.m. and 7 p.m., but this anthesis lasts only 15–20 minutes.

Körnicke says that in this species the chief flowering time is in the evening, while that of the morning is of a secondary nature; this order is exactly reversed in H. mollis *L.* Körnicke, however, thinks it not improbable that the secondary flowering may be suppressed.

Warnstorf describes the pollen-grains as white in colour when examined in water, globular, smooth, about 31 μ in diameter.

3021. H. mollis L.—MacLeod (Bot. Jaarb. Dodonaea, Ghent, v, 1893, p. 301) says that in this species the arrangement of flowers in the spikelet is the same as in the preceding one.

999. Arrhenantherum Beauv.

3022. A. elatius Mert. et Koch. (Godron, 'Floraison d. Graminées,' 1873; Kirchner, 'Beiträge,' p. 89; MacLeod, Bot. Jaarb. Dodonaea, Ghent, v, 1893, pp. 299–301; Kerner, 'Nat. Hist. Pl.,' Eng. Ed. 1, II, p. 297.)—This species is andromonoecious. Each spikelet contains two flowers, one hermaphrodite homogamous and one male; the two open simultaneously. The filaments then fall over immediately, so that the anthers hang downwards. The latter dehisce at their tips, so that automatic self-pollination is usually excluded (Kirchner). When they dehisce the anthers project widely, according to Kerner, owing to the great elongation of the filaments, which increase their original length three to four times in ten minutes. The filaments, at first stiff, now become limp, the anthers tip over and dehisce at their downwardly directed apices. The anther-lobes diverge in opposite directions,

each forming a boat-shaped cavity, in which the pollen rests while the air is calm. When the anthers are shaken by wind, this is removed little by little, until the loculi are completely empty.

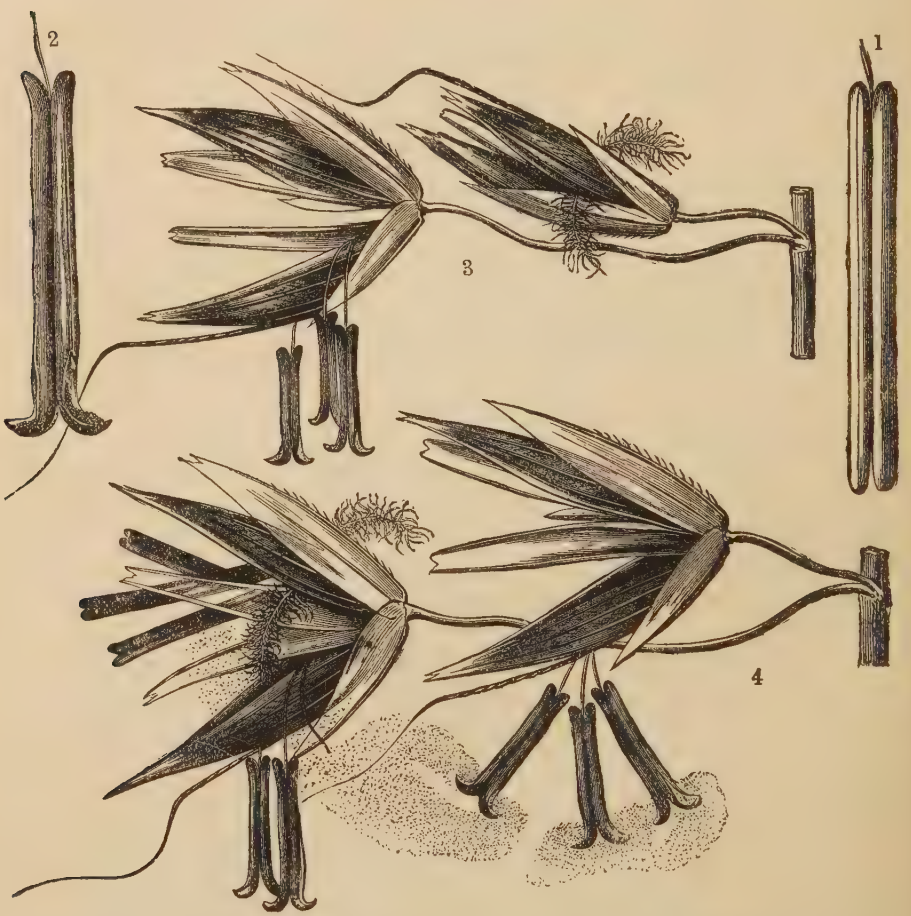


FIG. 418. *Arrhenantherum elatius*, Mert. et Koch (after Kerner). (1) Undehisced anther. 2) Dehisced do. (3) Spikelet with open glumes, and anthers hanging down in still air. (4) Do., when the air is in motion. The anthers of one flower are shedding their pollen, those of another have already done so (and one has dropped from its filament), those of a third have not dehisced and are pushing their way out from between the glumes.

1000. Avena L.

3023. A. Scheuchzeri All.—Kirchner ('Beiträge,' p. 8) describes this species as homogamous, but the stigmas remain receptive and hang down between the glumes when the anthers have fallen.

3024. A. pubescens L.—This species, according to Kirchner ('Flora v. Stuttgart,' p. 134), is feebly protogynous with persistent stigmas. The anthers do not dehisce until a short time after the divergence of the glumes, while the stigmas are

mature at the beginning of anthesis. These remain receptive within the still divergent glumes when the anthers have fallen. Cross-pollination is therefore possible at the beginning and end of anthesis. Warnstorf says that the anthers dehisce between 4 and 7 p.m. for the second time.

3025. A. sativa L.—This species is homogamous. Godron states that the flowers open between 2 and 4 p.m.; and that the stamens fall over before the anthers have dehisced, so that pollen cannot drop on the stigma of the same flower.

Although Godron thus considers that crossing predominates, Rimpau seems to think that automatic self-pollination is very certain, as the filaments elongate very slowly and the anthers dehisce close to the stigma. Rimpau observed several times that the anther-walls suddenly contract actively, and part of the pollen is thereby flung immediately upon the stigma. When cross-pollination is excluded the species is entirely fertile. Allogamy seems to occur as an exception in the smaller, upper flowers. (*Cf.* Hackel, Bot. Ztg., Leipzig, xxxviii, 1880.) Hildebrand considers that crossing is favoured rather than self-pollination. He states that in dry weather the flowers open in the afternoon or towards evening. In unfavourable weather the flower remains closed and pseudo-cleistogamous autogamy takes place. Von Liebenberg also describes the species as self-fertile.

Appel (in a letter to the author) considers the existence of transition-forms between A. sativa *L.* and A. fatua *L.* a proof of the occurrence of cross-pollination, at least in individual species. Haussknecht does not consider these transition-forms to be of hybrid origin, and infers that A. sativa is a cultivated form of A. fatua, produced by centuries of breeding, but Körnicke and Appel (the latter of whom observed these forms in large numbers near Coburg, Würzburg, and Schaffhausen) are more inclined to suppose that they are really hybrids. This opinion is strengthened by the fact that when further cultivated the plant becomes variable, even if cross-pollination is excluded.

Kirchner ('Flora v. Stuttgart,' p. 133) says that anthesis begins in the afternoon when the weather is favourable, and lasts until evening, proceeding from the apex of the panicle to its base. The lower of the two flowers of each spikelet opens first, and the other shortly after if the weather is favourable; as the flowers are usually pendulous the anthers sway in front of the stigmas during anthesis. If they dehisce before the stamens have finished elongating, self-pollination is effected freely, if later, this is prevented. Pollination takes place almost regularly within the flowers of the same panicle, and rarely crossing, which occurs only in the small flowers at the top of the spikelet.

According to Körnicke many varieties, besides opening in the afternoon, do so also, rarely or frequently as the case may be, in the morning, beginning in favourable weather before 8 a.m., and continuing for some hours. The bulk of the flowers, however, always open after midday.

The time of anthesis is, however, altogether subject to certain external influences; it may be delayed during hot dry weather by sunshine and the dryness of the soil. A brief shower can then cause a rapid opening of many flowers. Damp warm weather induces earlier anthesis.

3026. A. orientalis Schreb., and **3027. A. nuda** L.—Hildebrand describes

these species as homogamous, and says that they open their flowers like A. sativa in favourable weather, and are pseudo-cleistogamous when it is unfavourable.

3028. A. sterilis L.—This species is homogamous.

1001. Trisetum Pers.

3029. T. pratense Pers. (= T. flavescens *Beauv.*).—Kerner states that the anthers of this species dehisce about 7–8 a.m., and Warnstorf thinks this takes place 6–7 a.m. The pollen-grains are pyramidal, about 37 μ long and 25–8 μ broad. The flowers are homogamous.

1002. Eleusine Gaertn.

3030. E. coracana Gaertn.—Körnicke (op. cit.) says that the flowers of this species open. The tips of the stigmas reach those of the glumes. The longitudinally dehiscing anthers are situated on the same level as the stigmas, and as both mature simultaneously, are directed upwards, and are more or less apposed, self-pollination takes place, though crossing is not excluded.

1003. Poa L.

3031. P. abyssinica Jacq. (= Eragrostis abessinica *L.*). (Körnicke, op. cit.) —In this species fertilization usually takes place pseudo-cleistogamously, as the anthers hang against the stigmas, and, at least in the forms observed by Körnicke, the flowers do not open.

3032. P. pratensis L.—Kirchner ('Flora v. Stuttgart,' p. 141) describes this species as homogamous with persistent stigmas, which depend laterally out of the flower when the blue-grey anthers are emptied. Kerner says that species of this genus dehisce between 4 and 5 a.m. Beijerinck states that they are self-fertile.

3033. P. nemoralis L.—This species is homogamous, and the anthers dehisce towards midday. The pollen-grains are up to 37 μ in diameter (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896).

3034. P. annua L.—

Visitors.—Herm. Müller observed the hover-fly Melanostoma mellina *L.*

1004. Briza L.

3035. B. media L.—Hildebrand ('Bestäubungsverh. d. Gramineen,' p. 758) describes this species as homogamous. The anthers dehisce for the first time early in the morning, and for the second time between 6 and 7 p.m. The pollen-grains are pyramidal in form, about 40 μ long and 31 μ broad (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896).

1005. Glyceria R. Br.

3036. G. fluitans R. Br. (= G. plicata *Fries*).—Kirchner ('Beiträge,' p. 9) says that this species is protogynous with persistent stigmas. The two white, brush-like stigmas are mature when the glumes diverge. After the filaments have then elongated, the stamens bend over, and the bright-yellow anthers dehisce. After

a short time the glumes close again and grip the stamens and stigmas in doing so, the former with the emptied anthers at the tip, and the latter on both sides at the base of the flower. The stigmas seem to be still receptive when the anthers have fallen. Automatic self-pollination is excluded.

Warnstorf says that this species has dehisced by 6 a.m. Besides plants in which the glumes are closed by this time and the empty yellow anthers hang far out, there are others with widely opened glumes, and stigmatic branches and stamens situated within them; self-pollination is inevitable in this case.

3037. G. aquatica Wahlenb.—This species is homogamous, and the anthers dehisce between 5 and 6 p.m. (probably for the second time). The pollen-grains are whitish in colour, pyramidal in form, up to 50 μ long and 35 μ broad (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896).

3038. G. distans (= Festuca distans *Kunth*).—This species is homogamous. When the glumes diverge the anthers are situated on relatively short, stiff filaments, and project little beyond the long stigmatic branches, autogamy thus being easily possible. The anthers dehisce at 6 a.m. (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896).

1006. Molinia Schrank.

3039. M. caerulea Moench.—For the interesting observations on this species by Ludwig, see p. 516.

1007. Dactylis L.

3040. D. glomerata L.—Kirchner ('Beiträge,' p. 9) describes this species as freely protogynous with persistent stigmas. The filaments have not yet completely elongated nor the anthers dehisced when the stigmas are receptive and protrude laterally between the divergent glumes. When the filaments have reached their full length they do not bend downwards but remain stretched out rather stiffly, so that automatic self-pollination can now easily take place. The stigmas appear to be still receptive after the anthers have emptied their pollen. Hildebrand ('Bestäubungsverh. d. Gramineen,' p. 756) describes the flowers as homogamous, but states that cross-pollination is favoured. Kerner says that the flowers open between 6 and 7 a.m., but according to Warnstorf this takes place between 6 and 9 a.m.

Visitors.—Ludwig observed flies.

1008. Cynosurus L.

3041. C. cristatus L.—Hildebrand ('Bestäubungsverh. d. Gramineen,' p. 758) describes this species as homogamous. Cross- and self-pollination are favoured to about the same extent. The yellow or violet anthers are at first situated on long, stiff filaments, but soon become pendulous; the stigmatic branches project widely. The anthers dehisce between 6 and 7 a.m. The pollen-grains are pyramidal in form, irregularly whitish in colour, up to 37 μ long and 31 μ broad (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896).

Kirchner ('Flora v. Stuttgart,' p. 143) describes the anthers as partly red, partly yellow in colour.

1009. Festuca L.

Beijerinck describes species of Festuca as self-fertile. Herm. Müller observed the hover-fly Melanostoma mellina *L.* as a visitor.

3042. F. elatior L. (= F. pratensis *Huds.*).—Kirchner ('Flora v. Stuttgart,' p. 143) says that the anthers are partly red, partly yellow in colour. Hildebrand describes this species as homogamous, with cross- and self-pollination about equally possible. Warnstorf says that the stigmatic branches project far out of the divergent glumes; the yellow anthers, pendulous on long filaments, usually dehisce after projecting, more rarely inside the tips of the outer glumes as they bend downwards.

3043. F. pulchella Schrad., and **3044. F. varia** Haenke (= F. pumila *Chaix*). —As the filaments in these species do not bend downwards, but remain rather stiffly stretched out, self-pollination easily takes place (Schröter).

3045. F. rubra L., var. **fallax** Thuill, and **3046. F. rupicaprina** Hack.— The filaments in this species bend downwards, so that self-pollination is excluded (Schröter).

3047. F. ovina L.—

Visitors.—Delpino (Florence) observed beetles (Henicopus hirtus *L.* (= H. pilosus *Scop.*) and Nemognatha sp.) flying with great rapidity from one inflorescence to another ('Ult. oss.,' II).

3048. F. arundinacea Schreb.—This species is homogamous, and its anthers dehisce in the morning. The pollen-grains are white in colour, pyramidal, up to 50 μ long and 31–4 μ broad (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896).

3049. F. gigantea Vill.—This species is feebly protogynous; the glumes diverge and the stigmatic branches project widely before 6 a.m., while the anthers are still vertical and closed; these protrude between 6 and 7 a.m. and dehisce. During the morning the glumes close again, and only the empty anthers hang out. The pollen-grains are pyramidal in form, about 43 μ long and 37 μ broad (Warnstorf, op. cit.).

1010. Brachypodium Beauv.

3050. B. pinnatum Beauv.—Kirchner ('Flora v. Stuttgart,' p. 149) says that the stigmas still hang out of the glumes when the anthers have fallen. Warnstorf (Verh. bot. Ver., Berlin, xxxviii, 1896) describes the flowers as homogamous; the glumes diverge before 6 a.m., and the stamens dehisce between 6 and 7 a.m. The stigmatic branches project widely, and the anthers are pendulous on long filaments, autogamy being therefore excluded. The pollen-grains are whitish in colour, pyramidal, up to 46 μ long and 31–5 μ broad.

Visitors.—Herm. Müller observed a beetle.

1011. Graphephorum Desv.

3051. G. arundinaceum Aschers. (= Scolochloa festucacea *Link*, Festuca borealis *Mert. et Koch*, Fluminia arundinacea *Fries*, and Arundo festucacea *Willd.*). —Hildebrand ('Bestäubungsverh. d. Gramineen') says that this species is homogamous, but the still receptive stigmas project between the already closed glumes after the anthers have dehisced.

1012. Bromus Dill.

3052. B. secalinus L.—Hildebrand ('Bestäubungsverh. d. Gramineen') describes this species as homogamous. Self- and cross-pollination are possible to about the same extent. In favourable weather the flowers remain closed, and pseudo-cleistogamous fertilization takes place. Beijerinck describes the species of Bromus as self-fertile, and in Holland usually cleistogamous.

3053. B. erectus Huds.—Kirchner ('Beiträge,' pp. 9–10) says that this species is homogamous. The orange-yellow anthers bend downwards, however, directly after the divergence of the glumes, and also dehisce in that direction, so that as a rule self-pollination is not effected.

3054. B. mollis L.—The flowers of this species are usually only cleistogamous; chasmogamous ones have only twice been met with, between 7 and 8 a.m., and 10 and 11 a.m., closing again after a few hours (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896).

Visitors.—Herm. Müller observed a beetle.

3055. B. sterilis L.—This species has only been observed bearing cleistogamous flowers (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896).

3056. B. tectorum L.—This species usually bears cleistogamous flowers, and has only once been observed (at 6 p.m.) with open flowers and projecting stigmas and stamens (Warnstorf, op. cit.).

1013. Triticum L.

3057. T. vulgare Vill.—Delpino states that in this species the glumes diverge rapidly and suddenly. The anthers project laterally at the same time, dehisce, and empty about one-third of their pollen on the stigma of the same flower, while the rest is scattered into the air. This happens in about one minute, and after a quarter of an hour the glumes again close.

Delpino's experiments show that automatic self-pollination results to the setting of good fruits. He and Körnicke state that each flower remains open only about a quarter of an hour, but anthesis lasts four days, so that only a small number of flowers are found open at any one time (Herm. Müller, 'Fertlsn.,' p. 568).

Kirchner ('Flora v. Stuttgart,' p. 155) says that the homogamous flowers gradually open so widely that the tips of the glumes are about 4 mm. apart. The anthers dehisce apically at the same time, and about one-third of their pollen falls into the flower. They project after this and scatter the rest into the air. Self-pollination therefore takes place regularly, but cross-pollination by means of the wind is not excluded. The anthesis of a spike lasts four days.

Hildebrand states that self-pollination is rendered difficult by the tipping over of the anthers after the divergence of the glumes.

The flowers of the wheat resemble those of the rye as regards anthesis.

Godron says that the flowers open at 4.30 p.m. at 16° C., closing again at 6.30–7 p.m. If the anthers tip over quickly when the flower opens, the stigmas of the blossom are not as a rule dusted with their pollen. Under less favourable circumstances anthesis takes place more slowly, and the stigmas do not project until

they have been dusted with pollen from the same flower. At a low temperature (12–13° C.), or after several days' rain, the flowers remain closed, and pseudo-cleistogamous fertilization takes place.

Rimpau says that at a temperature of 12–13° C. the glumes do open a little, but not completely under 16° C. This is not, as Godron asserts, limited to the early morning hours, but may take place at any hour of the day or even in the evening. The length of anthesis depends on the temperature and the dryness of the air: at 23° C. the flowers closed again in 15–20 minutes; at a lower temperature this took place much more slowly. Rimpau found that the anthers dehisce before they have reached the upper margin of the glumes by elongation, so that automatic self-pollination is regularly effected in every flower; Godron observed the opposite. Rimpau and von Liebenberg also found that the species is fertile when cross-pollination is excluded. If self-pollination does not take place, crossing is sufficiently ensured, according to Rimpau's experiments, for out of 85 flowers from which the anthers were removed, 50 set fruits. Even in the fourth generation the results of crossing showed a distinct superiority over those produced by autocarpy as regards the average number of haulms formed (*cf.* Hackel, Bot. Ztg., Leipzig, xxxviii, 1880).

Kerner states that the anthers dehisce between 5 and 6 a.m. Warnstorf describes the pollen-grains as white in colour, ellipsoidal or ovoid, smooth, opaque, about 56 μ broad and 75 μ long.

3058. T. Spelta L.—This species possesses the same flower mechanism as the last one (Hildebrand, Kirchner). Askenasy states that the flowers remain pseudo-cleistogamously closed in unfavourable weather (Hansgirg).

3059. T. monococcum L.—The flower mechanism of this species resembles that of T. vulgare, but the glumes diverge more widely and the whole spike fades more quickly. The glumes diverge in the morning (Kirchner, 'Flora v. Stuttgart,' p. 156). Beijerinck also found the flowers to be self-fertile.

3060. T. dicoccum Schrank.—Hildebrand states that in this species the pollination of the stigma is only possible for a few minutes when the glumes diverge slightly, the anthers having then scattered only a part of their pollen.

3061. T. polonicum L.—In this species pseudo-cleistogamous fertilization predominates. In very many flowers the anthers always remain within the glumes and are then apposed to the stigmas. The glumes, however, do diverge for a short time, but only to a distance of about 2 mm. Körnicke says that the anthers usually dehisce at the tip only.

3062. T. ovatum Rasp. (= Aegilops ovata *L.*).—Godron says that the flowers of this species, which is indigenous to South Europe, Croatia, &c., open between 9.30 and 10 a.m. When the temperature is about 20–1° C. anthesis takes place rapidly, and the anthers tip over before they have dehisced, so that self-pollination is at that time impossible. If the temperature is lower anthesis is so slow that single flowers which have not been fertilized remain open until next day, and can then be dusted with the pollen of flowers belonging to other species, which open 2–3 hours earlier. Godron considers that this explains the fact that at Nancy, which is comparatively northerly, such hybrids arise automatically more easily than in more southerly districts. (According to Loew, 'Blütenbiol. Floristik,' p. 372.) Closely

related species (i. e. those sometimes included in the genus Aegilops) agree with T. ovatum in their manner of flowering, but Kirchner only rarely observed flowers still open after the proper period of anthesis.

3063. T. cylindricum Ces. Pass. et Gibb (= Aegilops cylindrica *Host*).—Hildebrand states that the homogamous flowers of this species, which is indigenous to Hungary, Slavonia, &c., open towards midday. After a slight divergence of the glumes, the dehiscent anthers tip over downwards; simultaneously the stigmas project laterally a little at the base of the flower, so that self-pollination can take place. The stigmas remain receptive and the flowers remain open for some time after the anthers have fallen, so that cross-pollination is now possible. (Loew, loc. cit.)

1014. Agropyron J. Gaertn.

3064. A. repens Beauv.—

Visitors.—MacLeod observed a Muscid (Spilogaster sp.).

3065. A. caninum Beauv.—The flowers of this species are protogynous and chasmogamous; the glumes diverge and the stigmas project at 8 a.m., the anthers do not dehisce until towards midday, and scatter their pollen when they protrude from the glumes. The pollen-grains are pyramidal in form, yellowish-white in colour, almost smooth, on an average 50 μ in diameter (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896).

1015. Secale L.

3066. S. cereale L. (Sprengel, 'Entd. Geh.,' pp. 79–80.)—Hildebrand states that in this species the anthers first project between the still partially closed glumes; when they have protruded to their bases they tip over, a part of the pollen falling out at the same time, so that the stigma of the same flower cannot be dusted. Later on the glumes diverge widely for some hours, and the stigmas now bend forward for the first time. Meanwhile the anthers have dehisced more fully and the pollen is gradually shaken out, reaching the stigmas of other flowers more easily, because the anthers are situated below the stigmas. Cross-pollination is therefore favoured, but autogamy not excluded (*cf.* Loew, 'Blütenbiol. Floristik,' p. 372).

Godron and Kerner state that the flowers open between 6 and 7 a.m. The former says that the anthers tip over immediately under favourable conditions, so that self-pollination cannot take place. In colder regions (northern latitudes or high mountain levels), cleistogamy or, according to Hansgirg, pseudo-cleistogamy, occurs.

Askenasy (Verh. nat.-hist. Ver., Heidelberg, New Ser., ii, 1879) states that after the divergence of the glumes the stigmas first bend rapidly downwards, and the stamens elongate, while the anthers dehisce simultaneously. Autogamy is, however, not completely excluded, but xenogamy or geitonogamy by means of the wind is generally effected.

Rimpau says that single flowers open at a temperature of 12½° C. The period of anthesis is not so limited as Godron asserts, but is distributed over the whole morning. Cross-pollination is ensured by projection of the stigmas for some time after the closing of the glumes. The self-sterility of the species described by

von Liebenberg as rendering the action of foreign pollen effective is, in Rimpau's opinion, not general; he considers that self-pollination takes place even if few fruits are set.

Beijerinck also describes the rye as self-sterile.

Rimpau (Landw. Ztg., Wien, xxx, 1880, p. 333) states that fertilization is certain and effective in proportion as the pollinated flower and the pollen with which it is dusted are of dissimilar origen.

Kirchner ('Flora v. Stuttgart,' p. 158) describes the flower mechanism of the species as follows. The flowers are homogamous, but the anthers do not dehisce until they project from the widely divergent glumes and have bent downwards. The stigmas protrude between the glumes, and remain outside for some time after they have closed again. Cross-pollination is thus usually effected, autogamy only rarely taking place with self-sterility as a result. In favourable weather the flowers begin to open after sunrise, and anthesis lasts until evening. The first flowers to open are situated at a height of two-thirds of the length of the spike; each remains open for a quarter of an hour. In unfavourable weather the flowers do not open, and fertilization is excluded.

1016. Elymus L.

3067. E. sabulosus Bieb.—The flowers of this species are homogamous, but Hildebrand says that the receptive stigmas project from the flower for some time after the closing of the glumes.

1017. Hordeum L.

3068. H. vulgare L.—Delpino states that in this species the flowers of the two middle rows never open, but fertilize themselves cleistogamously, while those of the four outer rows are homogamous, with a course of anthesis resembling that of wheat, so that the possibility of cross-pollination is not excluded. Darwin ('Diff. Forms of Fls.') says that species of this genus also possess cleistogamous flowers.

Von Liebenberg states that the flowers are already self-pollinated before the spike protrudes from the leaf-sheath.

Godron asserts that the flowers of all six rows open.

Kerner states that the pollen is scattered between 5 and 6 a.m. According to Rimpau the flowers open at a temperature of $12\frac{1}{2}^{\circ}$ C. He says that the middle spikelet seems to fade almost always with closed glumes, the latter only diverging extremely rarely. The lateral spikelets, however, open regularly. The possibility of cross-pollination is therefore slight.

3069. H. distichon L.—Delpino states that in this species only the flowers of the two middle rows are hermaphrodite, those of the four others being male, or, according to Hildebrand, neuter. Delpino says that the hermaphrodite flowers usually remain closed, pseudo-cleistogamy then taking place. Sometimes single larger ones open a little, however, so that cross-pollination by the male flowers becomes possible.

Godron says that the hermaphrodite flowers of the two middle rows only open if the temperature between 8 and 10 a.m. is favourable (18–20° C.).

Rimpau found that either the flowers all open together and their anthers project,

or else the anthers remain enclosed between the glumes during anthesis. But even in the first case automatic self-pollination is almost inevitable on account of the slight opening of the flowers and the early dehiscence of the anthers; it seems to be much more general than in wheat.

Kirchner ('Flora v. Stuttgart,' p. 159) says that the flowers of the two middle rows never open, but fertilize themselves pseudo-cleistogamously. Those of the lateral spikelets, on the contrary, open regularly; they are homogamous, and possess the same mechanism as those of wheat, so that automatic self-pollination usually takes place.

3070. H. hexastichon L.—Rimpau states that the flowers of this species open at a temperature of 12½° C. The middle spikelet seems to fade almost with closed glumes, but it sometimes opens; the lateral spikelets always open. Godron states that the flowers of all six rows of spikelets are hermaphrodite and fertile.

3071. H. Zeocriton L.—Rimpau says that the anthers of this species always dehisce while the glumes are completely closed. Godron also observed only cleistogamous flowers. Hansgirg describes them as pseudo-cleistogamous.

3072. H. murinum L.—Hildebrand says that in this species the flowers of the two middle rows of spikelets remain closed, and fertilize themselves. Those of the lateral ones are male. Their anthers project widely, so that their pollen can fertilize any hermaphrodite flowers which are opening. The lateral male flowers scatter their pollen between 6 and 7 a.m.; the blossoms of the middle spikelets are hermaphrodite and cleistogamous. (Warnstorf, Verh. bot. Ver., Berlin, xxxviii, 1896.)

3073. H. bulbosum L.—Hildebrand says that in this species two lateral male flowers are situated near each hermaphrodite one, and their anthers dehisce later. When the hermaphrodite flowers open, the anthers first force their way through the glumes. The stigmas then project downwardly to right and left through a slit in the latter on the side facing the axis of the spike. After the anthers have turned over, their dehiscent tips are situated below the stigmas, which remain receptive for some time after the pollen has been scattered. Cross-pollination may therefore easily take place, and can be effected by the pollen scattered from the lateral male flowers, the anthers of which dehisce subsequently. Wittmack considers the latter impossible; in specimens which he cultivated he found the pollen of the middle flowers completely ineffective. Sexual reproduction has undoubtedly been rendered superfluous by vegetative propagation, effected by means of the bulbous base of the stem. (According to Loew, 'Blütenbiol. Floristik,' pp. 370–1.)

1018. Sorghum L.

3074. S. vulgare Pers. (= Andropogon Sorghum *Brot.*). (Körnicke, op. cit.; Kirchner, 'Neue Beob.,' p. 11.)—Körnicke says that the flowers of this species open in the morning, when the glumes separate a little and stamens and stigmas protrude simultaneously. The filaments then bend over, but the anthers do not dehisce for some time, and the stigmas are usually pollinated before this takes place. Autogamy by retention of the reproductive organs between the glumes is not excluded. Kirchner describes this species as protogynous. He says that as soon as the glumes begin to diverge, the brush-like stigmas project laterally from between them. When

the flowers open more widely the anthers dehisce. The stigmas remain outside even after the glumes have closed, and they then gradually shrivel.

3075. S. saccharatum Pers.—Kirchner (op. cit.) describes this species as feebly protogynous. The stigmas and anthers project from the tips of the slightly diverging glumes, the ends of the two stigmas protruding at the beginning of anthesis.

1019. Lolium L.

3076. L. temulentum L.—Hildebrand ('Bestäubungsverh. d. Gramineen,' p. 758) describes this species as homogamous; cross- and self-pollination are favoured to about the same extent.

3077. L. perenne L.—This species, according to Kirchner ('Flora v. Stuttgart,' p. 161), is feebly protogynous, according to Warnstorf, feebly protogynous to homogamous; the glumes remain closed and the stigmas usually project from them rather earlier than the yellow or violet anthers, which hang downwards on long filaments. The pollen is scattered early in the morning.

3078. L. multiflorum Lam.—Kirchner (op. cit.) says that in flowers of this species the bright-yellow or grey-violet anthers do not dehisce until they are hanging outside the flower, so that automatic self-pollination does not take place.

1020. Nardus L.

3079. N. stricta L.—Axell describes this species as markedly protogynous.

1021. Arundinaria Michx.

3080. A. japonica Sieb. et Zucc. (C. Schröter, Neujahrsblatt d. natf. Ges., Zürich, 1886, quoted by M. Möbius, Mitt. aus d. bot. Gart. zu Frankfurt a. M., Ber. Senckenb. Ges., Frankfurt a. M., iii, 1898, pp. 81–9.)—Schröter states that all the plants of this species cultivated in the Botanic Gardens of Paris, Sceaux, Marseilles, and other places, bloomed in 1867, and 'in such a way that the oldest and youngest shoots were equally affected; even buds just emerging from the ground at once became flowering shoots.'

3081. A. Simoni A. et C. Rivière.—This species flowers and fruits under cultivation without dying down like other bamboos.

1022. Phyllostachys Sieb. et Zucc.

3082. P. nigro-punctata.—Although this species flowers and fruits freely only two seedlings have been obtained. A plant six feet high blossomed abundantly after a few years.

1023. Bambusa Schreb.

3083. B. vulgaris Schrad.—M. Möbius (op. cit., pp. 81–9) observed a characteristic method of flowering in a plant cultivated in the Frankfurt a. M. Botanic Garden. In several successive years fresh flowers were developed on the remains of the spikelets of the preceding season. The stock in question had grown for at least thirty years in the open air, and was transplanted into a flower-pot before it

began to blossom. Vegetative development was more and more checked during flowering, and in the third year a shoot about 60 cm. long was developed from the rhizome, which bore no leaves but only flowers. A lateral shoot was formed on an older haulm. The appearance of new flowers between those of the previous year may be explained by supposing that either some of those formed during that year only obtained their full development a twelvemonth later, or that young spikelets were formed as buds in the axils of the lower glumes of the first year spikelets, and attained maturity the next season.

When the sexually mature flowers open the red anthers of the six stamens project from between the glumes. In this species the anthers are not versatile, but fixed between the downwardly directed corrucate processes of the anther-lobes. The style divides above into three densely villous branches. Fruits were not set in the plants observed.

GYMNOSPERMAE.

CXXVI. ORDER *GNETACEAE* ENDL.

1024. Ephedra Tourn.

3084. E. campylopoda Mey. (Cavari and Rogasi, Rendiconti Congr. bot. di Palermo, 1902, abstracted in Bot. Centralbl., Cassel, xci, 1903, pp. 5–6.)—This species appears to be polyembryonous. Cavari and Rogasi state that pollination takes place in Cagliari towards the end of June or in July.

Strasburger observed a secretion of fluid at the tip of the micropyle, and a canal-like cavity at the end of the nucellus.

1025. Welwitschia Hook. f.

3085. W. mirabilis Hook. f.—In this species the curious stigma-like expansion at the tip of the ovule indicates an adaptation of the margin of the integument to insect-visits (Strasburger).

1026. Gnetum L.

3086. G. scandens Roxb. (G. Ula *Brongn.*). (Lotsy, Flora, Marburg, xcii, 1903, pp. 397–403.)—Lotsy, after examining a not quite complete lot of material, thinks it probable that in this species (unlike G. Gnemon *L.*) a large number of embryos are parthenogenetically developed in the upper part of the embryo-sac. Only a few of these come to maturity.

CXXVII. ORDER *CONIFERAE* JUSS.

All species of this order are anemophilous, the flowers being generally dioecious, more rarely monoecious. The male ones form a large quantity of very light, dry, mealy pollen, sometimes particularly adapted for removal by wind by appendages resembling little bladders filled with air. The pollen is sometimes so abundant that

during anthesis of the flowers in fir- or pine-woods it is often carried some distance by the wind and when washed to the ground by rain produces the phenomenon known as 'sulphur showers.'

The micropyle of the ovule secretes a drop of fluid during anthesis (Delpino, 'Ult. oss.,' II, 1870), which catches the pollen-grains brought by the wind and draws them into the micropyle as it dries up.

During pollination the apex of the nucellus becomes loosened, and usually excavated, being thus prepared to receive the pollen-grains and to render it easy for the pollen-tubes to penetrate the nucellar tissue. In Taxineae the pollen-grains, driven by the wind, reach the ovules directly; in Cupressineae they are partly guided to the orthotropous ovules by the ovuliferous scales; in Abietineae there are special organs for guiding the pollen, and in Pinus sylvestris *L.*, P. Pumilio *Haenke*, and Picea *Link*, the ovuliferous scales, and in Larix and Abies the carpels do this. A keel situated, in the first two species named, on the ovuliferous scale, in Larix *Tourn.* and Abies *L.* on the carpel, indicates the right way for the pollen-grains. In Picea the keel is absent, but the scales are so formed that pollination is easily effected without it (Strasburger).

Each pollen-grain of some monoecious species possesses, as has been mentioned above, two air-sacs, which render them very easy to move. Hartig (Bot. Ztg., Leipzig, xxv, 1867) assumes that these occur in pines, firs, and spruces, because the female flowers mature at the top of the tree very markedly in the two first and predominantly in the last, and the air-sacs therefore help the pollen-grains to move upwards and so reach the female flowers. This assumption does not, however, at all explain the presence of air-sacs in species of Podocarpus *Pers.*, Tsuga canadensis *Carr*, and others. Strasburger is of opinion that the facility of motion imparted to the pollen-grains of some species is attained by those of others in different ways, i.e. by great dryness and special smallness of the grains.

Strasburger points out another peculiarity of the cones: at the time of pollination they are usually of a beautiful bright-red colour, and become later an inconspicuous green or brown. Such colours are known to serve as attractions for insects in angiospermous plants. Such a significance is, however, impossible for the colouring of cones, as pollen is always removed by wind and transfer by insects has never yet been observed.

In angiospermous plants, Strasburger continues, the colouring of the perianth is an inherited peculiarity which is useful for pollination. But what of the coloration in Coniferae? It cannot be an inherited peculiarity, for the Coniferae cannot be derived from entomophilous plants. There is therefore no alternative but to take the red colouring of the cones during anthesis as a coincidence called forth secondarily by increased vitality at that time, and disappearing again later. We may suppose, says Strasburger, that the analogous colouring of the perianth in angiospermous plants also owes its origin to a similar cause, and was only found to be of value and further evolved as the result of insect pollination later on.

These last opinions I have extracted from Strasburger's memoir 'D. Bestäub. d. Gymnospermen' (Jenaische Zs. Natw., vi, 1871, pp. 249–61). He gives a detailed description of the methods of fertilization in his memoir 'D. Befrucht. d. Coniferen,' Jena, 1869.

The references given in the following descriptions are to the former work.

1027. Taxus L.

3087. T. baccata L. (Strasburger, op. cit., p. 253.)—In this species the micropyle of the ovule secretes a small drop of fluid, which catches the pollen-grains scattered by the lightest wind, so that each drop becomes filled with them. The drops then gradually evaporate and withdraw slowly into the micropyle, there being nothing to be seen of them towards evening. The pollen-grains have also been drawn into the micropyle and so reach the open tissue at the tip of the nucellus where they germinate. Kerner says that the shield-shaped connectives on the male flowers at first close up closely together like a little head, and cleft-like openings are formed between them, through which the pollen escapes into the air in dry weather, while in damp air the slits close up again. C. Sanio (D. bot. Monatsschr. Arnstadt, i, 1883, p. 52) states that the yew is not always dioecious, but sometimes monoecious. Warnstorf (Schr. natw. Ver., Wernigerode, xi, 1896) describes the pollen-grains as whitish-yellow in colour, irregularly tetrahedral, closely beset with small tubercles, 25–30 μ in diameter.

The pollination drops investigated by Schumann (Verh. bot. Ver., Berlin, xliv, 1902, pp. 5–80) perhaps contain, according to K. Frizi, glycose, together with a calcium compound and an unknown substance which reduces phospho-molybdic acid (Ber. D. bot. Ges., Berlin, xxi, 1903, pp. 211–17). If the drops are wiped off fresh ones can be secreted.

1028. Ginkgo L.

3088. G. biloba L. (= Salisburia adiantifolia *Sm.*). (Strasburger, op. cit., pp. 253–4.)—This species exhibits the same method of fertilization as Taxus. A clear drop of fluid is secreted during pollination on the margin of the micropyle, in which the pollen-grains are caught and drawn to the nucellus by evaporation later on. The tissue at the apex of the nucellus is open at this time, even partially dissolved, so that a deep canal is formed, leading almost into the middle of this region. The pollen-grains which find their way into this cavity can easily force their tubes between the loose cells.[1] The process again lasts several days. When pollination is over the edges of the micropyle thicken, so that this is closed.

1029. Juniperus Tourn.

3089. J. communis L. (Strasburger, op. cit., p. 255.)—This species is dioecious. At the time of pollination the three ovules with elongated necks project between the three basally united carpels, and excrete a watery fluid; the margins of the micropyle are somewhat expanded, delicately indented and wide open, so that the pollen-grains can easily find their way in. The apex of the nucellus is hollowed out and ready for the reception of the pollen. After pollination the margin of the micropyle and the apex of the nucellus shrivel. Kerner says that the anthers of the male flowers dehisce as in Taxus. At Stockholm and on the Dovrefjeld Forsberg (Bot.

[1] Ikeno and others describe the formation of two mobile spermatozoids in the end of the pollen-tube.—Tr.

Centralbl., Cassel, xxxiii, 1888, p. 91) found the relative numbers of male and female stocks varying greatly according to the nature of the soil; to 100 male plants he found 63 female ones in a light fir-wood; while the proportion was 100 : 143 on the poor sandy soil of the Dovrefjeld.

3090. J. rigida Sieb. et Zucc. (Strasburger, op. cit.)—This species possesses the same flower mechanism as the last one.

3091. J. Sabina L.—As Nos. 3089 and 3090.

1030. Pinus L.

3092. P. sylvestris L. (Sprengel, 'Entd. Geh.,' pp. 432–3; Strasburger, op. cit., pp. 251–3.)—This species is monoecious. The young female cones are situated close to the tip of the youngest shoot, before the unfolding of the double needles; they are arranged singly or several together in a vertical position, so that they are accessible from all sides. The ovuliferous scales possess a projecting, elongated keel in the middle and diverge a little during anthesis, in consequence of the lengthening of the axis of the cone. Two ovules are situated, one to the right and one to the left, at the base of every scale, and that margin of their micropyle which is turned towards the axis has now grown into two long, lateral processes, formed of colourless, transparent cells turgid with fluid, and secreting abundantly. If the pollen-grains, which are scattered in large dust-clouds by the lightest breeze, fall on the young cones they slip down the vertical scales on each side of the keel, reach the fluid-secreting processes, and are gradually drawn to the ovules. The keel of the scale causes the pollen-grains to slip down on the smooth, dry surface and easily reach the ovules. Those which fail to do this fall into one of the passages running right and left round the axis in consequence of the narrow insertion of the scales, and may then pollinate more deeply-placed ovules. After pollination has been effected the scales thicken rapidly and close up together, the resin secreted at their edges helping them to adhere. The keel does not develop further, but dries gradually. The original beautiful brownish-red colour disappears, and the cone gradually becomes pendulous. The micropyle still remains open for a long time, and is only closed much later by the extensive thickening of its edges. Kerner says that the pollen on being scattered is first deposited in two shallow grooves on the back of the anther next below, whence it is then removed by the wind.

Visitors.—Redtenbacher records the following beetles.—

(Austria)—(*a*) *Alleculidae*: 1. Omophlus amerinae *Curt.* (*b*) *Telephoridae*: 2. Dasytes obscurus *Gyll.*; 3. Haplocnemus pini *Redt.*; 4. H. pini *Redt.*, var. serratus *Redt.*; 5. H. tarsalis *Sahlb.* (Vienna)—(*c*) *Curculionidae*: 6. Brachonyx indigena *Hbst.*; 7. Magdalis violacea *L.*

3093. P. Pumilio Haenke. (Strasburger, op. cit.)—Strasburger says that this species possesses exactly the same pollination mechanism as the last one.

3094. P. Pinaster Ait., and **3095. P. rigida** Mill.—These species agree with the two last.

3096. P. resinosa Ait.—This species is similar in all respects, except that the keel is directed inwards. (Strasburger, op. cit., foot-note.)

3097. P. Strobus L.—Agrees with No. 3098.

1031. Picea Link.

3098. P. excelsa Link (= P. vulgaris *Link*, Pinus Abies *L.*, P. Picea *Duroi*, and Abies excelsa *Poir.*). (Strasburger, op. cit., p. 253.)—This specimen is monoecious. The pollination mechanism agrees essentially with that of Pinus sylvestris. The young female cones develop singly from the terminal buds of the branches of the current year branch; they are considerably larger than those of Pinus sylvestris, and therefore project between the mature needles of the branch. Only the inner halves of the obovate ovuliferous scales are vertical, the outer halves being almost horizontal. They possess no keel, so that the pollen is guided downwards between the projecting middle and the two slightly-inwardly curved edges of the inner halves of the scales. The ovules follow the same course as those of the pines, and the mechanism also agrees in other respects with that of Pinus sylvestris. After pollination the cones, hitherto of a beautiful red, become brown and green in colour, and pendulous in position; the scales become gradually vertical and adhere closely. Kirchner ('Flora v. Stuttgart,' p. 53) says that the female inflorescences of the same tree mature somewhat earlier than the male, so that cross-pollination is favoured.

Visitors.—The following were recorded by the observers, and for the localities stated.—

Redtenbacher (Austria), the Cantharid beetle Cantharis tristis *F.*, and the weevil Otiorhynchus multipunctatus *F.* Von Fricken (Westphalia), the Anthicid beetle Ptinus dubius *Strm.*

3099. P. alba Link, and **3100. P. nigra** L.—These species, according to Lambert ('A Description of the Genus Pinus,' London, 1803), and drawings by Parlatore ('Stud. organograf. sui fiori e sui frutti d. Conif.,' Firenze, 1864), agree with P. excelsa.

1032. Tsuga Carr.

3101. T. canadensis Carr. (= Pinus canadensis *L.*).—As Nos. 3099 and 3100.

1033. Cedrus Mill.

3102. C. Libani Barrel. (Strasburger, op. cit., pp. 253–4, foot-note.)—As Nos. 3099 and 3100.

1034. Larix Tourn.

3103. L. europaea DC. (= L. decidua *Mill.*, Pinus Larix *L.*, Abies Larix *Poir.*). (Strasburger, op. cit., pp. 254–5.)—This species is monoecious. The carpels are highly developed and make up the bulk of the cone during anthesis, while the ovuliferous scales then consist almost entirely of the two ovules only; the former must therefore guide the pollen. They are violet or purple-red in colour, ovoid, rounded above, vertical and slightly bent outwards; there is an indication of a keel in the middle, which is produced outwards by itself for a short distance. As the lateral margins of the carpels are curved slightly inwards, a groove is formed on each side of the keel, in which the pollen-grains slide down to the small ovuliferous scale:

they are guided to the left or right on the margins of the latter. Corresponding to this mechanism the pollen-catching process of the ovule is unilateral, and forming a broad lobe directed up- and inwards, and curved in like a helmet, in which the pollen-grains sliding down the side of the scale must fall. After pollination the cones remain vertical. Kerner states that the anthers of the male flowers dehisce in the same way as those of the pines. Warnstorf (Schr. natw. Ver., Wernigerode, xi, 1896) describes the pollen-grains as pale-yellow in colour, hemispherical, smooth, 75-87 μ in diameter.

1035. Abies L.

3104. A. pectinata DC. (= A. alba *Mill.*, Pinus Picea *L.*, and P. Abies *Duroi*). (Strasburger, op. cit., p. 255.)—This species is monoecious. The pollination mechanism closely resembles that of the larch; here again the guiding of the pollen is performed by the carpels. These are provided with a long keel, while the small, fleshy ovuliferous scales remain concealed in the axils of the carpels. There is also a similar unilateral galeate lobe to each ovule for catching the pollen-grains. After pollination the cones remain vertical.

3105. A. balsamea Mill. (= Pinus balsamea *L.*).—This species possesses a similar pollen mechanism to those of larch and silver firs, according to Richard ('Commentatio botanica de Conifer. et Cycad.,' 1826).

1036. Thuya L.

3106. T. orientalis L., and **3107. T. occidentalis** L. (Strasburger, op. cit., p. 256.)—These and other species possess a similar mechanism to that of the larch. The young female flowers are vertical, and the ovules are situated fairly deeply between the ovuliferous scales, but the micropyle always projects so far during anthesis that the pollen-grains can easily fall upon it, or can be guided to it by the scales.

1037. Oxycedrus Hart. (= Juniperus *Tourn.*, according to the *Index Kewensis*). Similar to Larix.

1038. Callitris Vent.

3108. C. quadrivalvis Vent.—This species resembles Thuya.

1039. Dacrydium Soland.; **1040. Phyllocladus** Rich.; **1041. Torreya** Arn., **1042. Cephalotaxus** Sieb. et Zucc.; **1043. Saxegothaea** Lindl.; and **1044. Podocarpus** Pers.

Species of these genera most closely resemble Taxus and Ginkgo (Salisburia). (Strasburger, op. cit.)

1045. Cupressus Tourn.

Similar to Thuya.

3109. C. sempervirens L. (Strasburger, op. cit., pp. 256–7.)—In this species the cone is formed by a large number of decussate ovuliferous scales, at the base of

each of which are situated numerous vertical ovules close together. The upwardly-directed scales assist in guiding the pollen, though this is not conveyed to each individual ovule, the separate grains sliding down the inner surface of the scales and falling on the ovules, so that large numbers of these are pollinated at the same time.

1046. Cryptomeria D. Don.

3110. C. japonica D. Don.—This species agrees with those of Abietineae. Three vertical ovules are situated at the base of each ovuliferous scale. The pollen-grains are directed straight to them by the scales.

1047. Taxodium Rich.

3111. T. heterophyllum Brongn. (= Glyptostrobus heterophyllus *Endl.*).—This species and those of Taxodineae in general agree with No. 3110. (Strasburger, op. cit., p. 257.)

CXXVIII. ORDER *CYCADEAE* C. RICH.

1048. Cycas L.[1]

3112. C. revoluta L.—Schenck says that all the ovules of this species secrete drops of fluid during anthesis. This characteristic seems therefore to be peculiar to all gymnosperms. (Strasburger, op. cit., p. 257.)

[1] Various investigators have described two ciliated spermatozoids as being formed in the tip of the pollen-tube in species of this genus.—Tr.

SYSTEMATIC LIST OF INSECT VISITORS

Mentioned in Vols. II and III; arranged alphabetically, with the names of plants visited.

Synonyms in italics. Cross-references are given from entries under usual names to synonyms, and conversely. In some cases the length of the proboscis is stated in parentheses after the name of an insect. The following symbols are employed to indicate the nature of visit to some of the more important plants :—

F + I + Useful to both flower and insect.
(F + I +) Sometimes ditto.
F + I ± Useful to flower, but useless to insect.
F ± I ± Useless to both flower and insect.
F − I + Useless or harmful to flower, useful to insect.
F − I − Harmful to both flower and insect.
↑ Casual visit.
↓ The insect merely observed settling.
* Insects which effect all three kinds of legitimate pollination in Lythrum Salicaria *L.*

I. ARACHNIDA

1. Acarida

1. Genus et sp. ? Narc. Pseudo-Narc. ↑

A. Trombidiidae.

2. Rhyncholopus phalangioides *Deg.*—Gal. Moll.

2. Araneida

A. Philodromidae.

3. Philodromus aureolus *Clerck.*—Ulex europ. F±A±. (A=Arachnid.)

B. Thomisiidae.

4. Thomisus onustus *Walck.*—Convolv. arv.
5. Xysticus pini *Hahn.*— Tussil. Farf., Bellis per.

II. COLEOPTERA

A. Alleculidae (=*Cistelidae*).

6. *Cistela murina L.* (=Gonodera murina *L.*, cf. No. 9).—Ranunc. acris, R. rep., R. bulb., Geran. pyren., Rosa centif., Spir. sorbif., S. salicif., S. ulmif., Aegopod. Podagr., Anthrisc. sylv.
7. *C. sulphurea L.* (= Cteniopus sulphureus *L.*, cf. No. 8).—Heracl. sibir., Daucus Car.
8. Cteniopus sulphureus *L.* (cf. No. 7).—Castan. sativa, Conium mac., Pimpin. Saxifr., Peuced. Oreosel., Mentha piper.
9. Godonera murina *L.* (=*Cistela murina L.*, cf. No. 6).—Sinap. arv.
10. Hymenalia rufipes *F.*—Veron. Cham.
11. Omophlus amerinae *Curt.*—Pinus sylvestr.
12. *O. longicornis Bert.* (=O. dilatatus *Fald.*).—Vit. ripar.
13. Podonta nigrita *F.*—Anthemis arv.

B. Anisotomidae.

14. Anisotoma obesa *Schmidt.*—Viburn. op.

C. Anobiidae.

15. Anobium paniceum *F.*—Crat. Oxyac.
16. A. Striatum *Ol.*—Apocyn. androsaemif. F±I±.

D. Anthicidae.

17. Ptinus dubius *Strm.*—Picea excelsa.
18. *Notoxys cornutus F.* (=N. trifasciatus *Rossi*).—Vit. vinif.
19. N. monoceros *L.*—Vit. vinif., Potent. rept.

E. Anthribidae.

20. Urodon conformis *Suffr.*—Res. luteola.
21. U. rufipes *Oliv.*—Res. luteola, R. lutea.

F. Bruchidae.

22. Bruchus olivaceus *Germ.*—Bupleur. rotundif., Allium rot.
23. B. pisi *L.*—Vicia sep. F±I+.
24. B. seminarius *L.*—Caltha pal.
25. B. villosus *F.*—Saroth. scop. F±I+.
26. B. sp.—Ranunc. acris, R. rep., R. bulb., Carum Carvi, Anthrisc. sylv., Anthem. arv., Cirs. arv.
27. Spermophagus cardui *Stev.*—Helianth. vulg., Dianth. Carthus., V. vinif., Vit. ripar., Rubus frutic., Potent. verna, Aegop. Podagr., Bupleur. rotundif., Daucus Car., Orlaya grandifl., Tanac. corymb., Carduus acanth., Sonchus arv., Conv. arv., Rheum undul.

G. Buprestidae.

28. Acmaedora flavofasciata *Pill.*—Res. odor.
29. Agrilus coeruleus *Rossi.*—Prenanth. purp.
30. Anthaxia millefolii *F.*—Achill. Millef., A. Ptarm.
31. A nitidula *L.*—Ranunc. acris, R. rep., R. bulb., Helianth. vulg., Rosa can., Crat. Oxyac., Achill. Millef., A. Ptarm., Anthem. tinct., Tanac. corymb., Tarax. off., Hierac. Pilos.
32. A. quadripunctata *L.*—Ranunc. acris, R. rep., R. bulb., Helianth. vulg., Potent. arg., Doron. austr., Thrinc. hirta, Scorz. hispan., Lact. vimin., Hierac. Pilos.
33. Coraebus elatus *F.*—Potent. arg.
34. Sphenoptera Rarelini *Falderm.*—Alkagi camel.
35. Trachys nana *Hbst.*—Geran. sanguin.

H. Byrrhidae.

36. Byrrhus pilula *L.*—Sedum album.
37. Cistela sericea *Forst.*—Veron. Cham.
38. Pedilophorus aeneus *F.*—Batrach. aquat.

J. Carabicidae.

39. Amara familiaris *Duft.*—Cerast. triv.
40. A. sp.—Cerast. arv.
41. Carabus cancellatus *Ill.*—Thymus serp.
42. C. violaceus *L.*—Aegopod. Podagr.
43. Lebia crux-minor *L.*—Cirs. arv.

K. Cerambycidae.

44. Acmaeops collaris *L.* (cf. No. 73).—Heracl. Sphond., Convall. maj.
45. *Anaglyptus mysticus L.* (=Clytus mysticus *L.*, cf. No. 54).—Vit. vinif.
46. Aromia moschata *L.*—Heracl. Sphond.
47. Callidium violaceum *L.*—Aegop. Podagr., Chaeroph. Villarsii.
48. Callimus cyaneus *F.* (=C. angulatus *Schr.*).—Heracl. Sphond.
49. Cerambyx cerdo *L.*—Ligustr. vulg.
50. C. scopolii *Fuessl.*—Sorbus Auc.
51. Clytus arietis *L.*—Rosa centif., Rubus frutic., Spir. sorbif., S. salicif., S. ulmif., Sorbus Auc., Heracl. Sphond., Anthrisc. sylv., Cornus sang.
52. C. figuratus *Scop.* (cf. No. 56).—Vit. vinif., Ulmar. pentapet.
53. C. massiliensis *L.*—Res. odor.
54. C. mysticus *L.* (cf. No. 45).—Crat. Oxyac., Heracl. Sphond.
55. C. ornatus *Hbst.*—Res. odor., Vit. vinif., Centaur. rhen.
56. *C. plebeius F.* (=C. figuratus *Scop.*, cf. No. 52).—Centaur. rhen.
57. Gaurotes virginea *L.* (cf. No. 77).—Ulmar. pentap.
58. *Grammoptera levis F* (=G. tabacicolor *Deg.*, cf. No. 60).—Asper. odor., Listera ovata. F+I+.
59. G. ruficornis *F.*—Anem. sylv., Prunus Padus, Rosa centif., Fragaria vesca,

Ulmar pentapet. Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Aegop. Podagr., Anthrisc. sylv., A. Ceref., Myrrhis odor.

60. Grammoptera tabacicolor *Deg.* (cf. No. 58).—Cornus sang.
61. Judolia cerambyciformis *Schr.* (cf. No. 75).—Rubus fructic., Ulmar. pentapet., Pimpin. Saxifr., Symphoricarp. racem. F+I+, Knaut. arv., Chrysanth. Leuc.
62. Leptura livida *F.*—Sinap. arv., Cerast. arv., Rubus frutic., Ulmar. pentapet., Spir. sorbif., S. salicif., S. ulmif., Aegopod. Podagr., Pimpin. Saxifr., Oenanthe aquat., Anethum graveol., Anthrisc. sylv., Chaeroph. tem., Cornus sang., Galium saxat., Knaut. arv., Bellis per., Achill. Millef., A. Ptarm., Anthem. arv., Matric. Chamom., Chrysanth. Leuc., Hier. Pilos., Jas. mont., Conv. arv., Euphorb. Gerard, Bromus mollis.
63. *L. melanura L.* (=Strangalia melanura *L.*, cf. No. 90).—Orchis. mac. F+I+.
64. L. maculicornis *Deg.*—Rubus frutic., Ulmar. pentapet., Sedum album, Heracl. Sphond., Knaut. arv., Chrysanth. Leuc., Jas. mont.
65. L. sanguinolenta *L.*—Aegopod. Podagr., Daucus Car., Anthrisc. sylv.
66. L. testacea *L.*—Libanot. mont., Heracl. Sphond., Galium sylv., Achill. Millef., A. Ptarm., Chrysanth. Leuc., Cirs. arv., Mentha aquat.
67. L. virens *L.*—Sambuc. racem., Polygon. Bistorta.
68. Molorchus minimus *Scop.*—Ulmar. pentapet.
69. M. minor *L.*—Crat. Oxyac., Libanot. mont.
70. Obrium brunneum *F.*—Ulmar. pentapet., Chaeroph. tem.
71. Oxymirus cursor *L.*—Anthrisc. sylv.
72. Pachyta clathrata *F.*—Polygon. Bist.
73. *P. collaris L.* (=Acmaeops collaris *L.*, cf. No. 44).—Anthrisc. sylv.
74. P. lamed *L.*—Heracl. Sphond.
75. *P. octomaculata F.* (=Judolia cerambyciformis *Schr.*, cf. No. 61).—Rubus Id., Aegopod. Podagr., Pimpin. Saxifr., Angel. sylv., Heracl. Sphond., Anthrisc. sylv., Chaeroph. tem., Cornus sang., Knaut. arv., Chrysanth. Leuc.
76. P. quadrimaculata *L.*—Ulmar. pentapet., Aegopod. Podagr., Pimpin. magna, Angel. sylv., Heracl. Sphond., Anthrisc. sylv.
77. *P. virginea L.* (=Gaurotes virginea *L.*, cf. No. 57).—Aegopod. Podagr., Heracl. Sphond., Cirs. arv.
78. Phytoecia nigricornis *F.*—Euphorb. Cypariss.
79. Rhopalopus insubricus *Germ.*—Sorbus Auc.
80. *Stenocorus inquisitor F.* (=S. mordax *Deg.*, cf. No. 81).—Rosa can.
81. S. mordax *Deg.* (cf. No. 80).—Ulmar. pentapet., Heracl. Sphond.
82. Stenopterus rufus *L.*—Sedum alb., Achill. Millef.
83. *Strangalia annularis F.* (=S. arcuata *Pz.*, cf. No. 84).—Heracl. Sphond.
84. S. arcuata *Pz.* (cf. No. 83).—Aegopod. Podagr.
85. *S. armata Hbst.* (= S. maculata *Poda.*, cf. No. 89).—Rubus frutic., Spir. sorbif., S. salicif., S. ulmif., Sedum alb., Angel. sylv., Peuced. pal., Heracl. Sphond., Siler tril., Daucus Car., Anthrisc. sylv., Cornus sang., Knaut. arv., Chrysanth. Leuc.
86. S. atra *Laich.*—Rosa centif., Rubus frutic., Carum Carvi, Cornus sang., Knaut. arv., Orchis mac.
87. S. attenuata *L.*—Rosa centif., Ulmar. pentapet., Spir. sorbif., S. salicif., S. ulmif., Heracl. Sphond., Anthrisc. sylv., Cornus sang., Knaut. arv., Matric. Chamom., Chrysanth. Leuc.
88. S. bifasciata *Müll.*—Rubus frutic., Ulmar. Filip., Libanotis mont., Peuced. cervar., Heracl. Sphond., Daucus Car., Orlaya grandifl., Galium verum, G. boreale, Knaut. arv., Inula hirta, Achill. Millef., A. Ptarm., Anthem. tinct., Tanac. corymb., Plant. med., Antheric. ramos.
89. S. maculata *Poda* (cf. No. 85).—Rosa can., Anthrisc. sylv.
90. S. melanura *L.* (cf. No. 63).—Rubus frutic., Epil. angust., Sedum alb., Pimpin. Saxifr., Libanot. mont., Heracl. Sphond., Anthrisc. sylv., Chaeroph. Villarsii, Galium ver., Knaut. arv., Achill. Millef., A. Ptarm., Tanac. corymb., Chrysanth. Leuc., Cirs. arv., C. pal., Jas. mont., Polygon. Bist., Euphorb. Gerard.
91. S. nigra *L.*—Ranunc. acris, R. rep., R. bulb., Sinap. arv., Helianth. vulg., Rubus frutic., R. Id., Spir. sorbif., S. salicif., S. ulmif., Pimpin. Saxifr., Heracl. Sphond., Plant. med.
92. S. quadrifasciata *L.*—Ulmar. pentapet., Libanot. mont., Sambuc. racem.
93. Tetropium luridum *L.*—Chaeroph. Villarsii.
94. Tetrops praeusta *L.*—Prunus avium.
95. Toxotus meridianus *L.*—Anthrisc. sylv., Knaut. arv.

L. Chrysomelidae.

96. Adoxus obscurus *L.*—Epil. angustif.
97. A. obscurus *L.*, var. vitis *F.*—Vit. vinif.
98. Agelastica alni ᵀ.—Batrach. aquat.
99. A. halensis *L.*—Galium verum.
100. Aphthona caerulea *Payk.*—Calla pal.
101. A. nemorum *L.*—Teesdal. nudicaul.
102. Cassida murraea *L.*—Pulic. dysent.
103. C. nebulosa *L.*—Teesdal. nudicaul., Solid. trifol.
104. C. nobilis *L.*—Crucianella angustifol., Calla pal. †
105. Chaetocnema concinna *Marsh.*—Teesdal. nudicaul.
106. Chrysochus pretiosus *F.*—Hier. Pilos.
107. Chrysomela cacaliae *Schr.*, subsp. senecionis *Schumm.*—Adenost. Alb.
108. C. varians *Schall.*—Hyper. perfor.
109. Clytra affinis *Hellw.*—Vit. vinif.
110. C. cyanea *F.*—Crat. Oxyac.
111. C. diversipes *Letz.*—Polygon. Bist.
112. C. musciformis *Göze.*—Vit. vinif.
113. C. quadripunctata *L.*—Chrysanth. Leuc.
114. C. scopolina *L.*—Pimpin. Saxifr., Peuced. Cervar.
115. Colaphus sophiae *Schall.*—Sisymbr. Sophiae.
116. Crepidodera ferruginea *Scop.*—Daucus Car., Succ. prat., Centaur. nigra, Mentha aquat.
117. Crioceris asparagi *L.*—Asparag. off.
118. C. duodecimpunctata *L.* (cf. No. 140).—Carum Carvi, Anthrisc. sylv., Asparag. off.
119. Cryptocephalus bipunctatus *L.*—Cirs. pal.
120. C. duodecimpunctatus *F.*—Rosa can.
121. C. flavipes *F.* Euphorb. Cypariss.
122. C. hypochoeridis *L.*—Hypoch. rad., Tarax. off.
123. C. lobatus *F.*—Crat. Oxyac.
124. C. moraei *L.*—Genista tinct. F±I+, Cirs. pal., Hier. Pilos.
125. C. sericeus *L.*—Ranunc. acris, R. rep., R. bulb., Chelidon. maj., Hyper. perfor., Genista tinct. F±I+, Rosa rubigin., Ulmar. pentapet., Heracl. Sphond., Knaut. arv., Succ. prat., Achill. Millef., A. Ptarm., Anthem. tinct., Cirs. arv., Carduus acanth., Centaur. Scab., C. rhen., Leont. aut., Crep. bien., Hier. Pilos., H. muror., Jas. mont.
126. C. violaceus *Laich.*—Crataeg. Oxyac.
127. C. vittatus *F.*—Saroth. scop. F±I+, Genista tinct. F±I+, Chrysanth. Leuc., Cirs. pal.
128. Donacia dentata *Hoppe.*—Nuph. lut.
129. D. discolor *Hoppe.*—Caltha pal.
130. D. sparganii *Ahr.*—Nuph. lut.
131. Galeruca calmariensis *L.*—Myrrhis odor.
132. G. nymphaeae *L.*—Ranunc. acris, R. rep., R. bulb.
133. Gatrophysa polygoni *L.*—Tarax. off.
134. *Gonioctena olivacea Forst.* (=Phytodecta olivacea *Forst.*).—Saroth. scop. F±I+.
135. Haltica oleracea *L.*—Oenoth. grandifl.
136. H. sp.—Prunus avium, Euphorb. Cypariss.
137. *Helodes marginella L.* (=Prasocuris marginella *L.*).—Caltha pal.
138. *H. phellandrii L.* (= Prasocuris phellandrii *L.* cf. No. 148).—Batrach. aquat.
139. Lema cyanella *L.*—Valerian. olit.
140. *L. duodecimpunctata L.* (=Crioceris duodecimpunctata *L.*, cf. No. 118).—Toril. Anthrisc.
141. Lochmaea sanguinea *F.*—Sorbus Auc.
142. *Longitarsus fuscicollis Foudr.* (= L. atricillus *Gyll.*, cf. No. 149).—Ranunc. Fic.
143. Luperus circumfusus *Marsh.*—Euphorb. Cypariss.
144. L. flavipes *L.*—Rosa can., R. rubigin., Galium bor.
145. Mantura fuscicornis *L.*—Malva sylv.
146. Prasocuris glabra *Hbst.*, and var. aucta *F.*—Ranunc. acris, R. rep., R. bulb.
147. P. junci *Brahm* (=P. beccabungae *Ill.*).—Jeron. Beccab.
148. P. phellandrii *L.* (cf. No. 138).—Oenanthe aquat.
149. *Thyamis fuscicollis Foudr.* (=Longitarsus atricillus *Gyll.*, cf. No. 142).—Tussil. Farf.

M. Cleridae.

150. Trichodes alvearius *F.*—Rosa can.
151. T. apiarius *L.*—Ranunc. acris, R. rep., R. bulb., Ulmar. pentapet., Sedum alb., Aegopod. Podagr., Heracl. Sphond., Toril. Anthrisc., Anthrisc. sylv., Chrysanth. Leuc., Cirs. arv., Ligustr. vulg.

N. Coccinellidae.

152. Coccidula rufa *Hbst.*—Oenanthe aquat.
153. Coccinella bipunctata *L.*—Vit. ripar., Peuced. pal., Prangos ferulacea, Tanac. vulg., T. tanacetoid., Doron. caucas., Senec. macrophyll., Mentha piper., Leonur. lanat.
154. *C. Conglobata L.* (=C. quattuordecimpunctata *L.*, cf. Nos. 158 and 165).—Berb. vulg., Pyrus comm., Parnass. pal.
155. *C. impustulata L.* (=C. octodecimpunctata *Scop.*, var. impustulata *L.*, cf. No. 157).—Chrysoc. Linos., Diplopapp. amygdal., Anthem. tinct.
156. C. mutabilis *Scrib.*—Daucus Car., Achill. Millef., A. Ptarm., Onopord. Acanth.
157. C. octodecimpunctata *Scop.* (cf. No. 155).—Medic. med.
158. C. quattuordecimpunctata *L.* (cf. Nos. 154 and 165).—Ranunc. lanugin., Astrant. major, var. involucr., Sium latif., Angel. sylv., Anthrisc. sylv., Antenn. dioica, Helichrys. aren., H. bract., Ammob. alatum, Achill. filipend., Anthem. tinct., Polygon. Bist.
159. C. quinquepunctata *L.*—Daucus Car., Antenn. dioica, Helichrys. bract., Tanac. vulg., Hier. umbell.
160. C. septempunctata *L.*—Berb. vulg., Arab. alb., Sinap. arv., Cak. marit., Vit. ripar., Erod. Cicut., Parnass. pal., Conium mac., Pimpin. Saxifr., Angel. sylv., Peuced. pal., Ferulago montic., Daucus Car., Anthrisc. sylv., Chaeroph. hirs., Achill. Millef., A. Ptarm., Cirs. arv., Tarax. off., Euphorb. dendroid.
161. C. undecimpunctata *L.*—Conium mac., Salix rep.
162. C. variabilis *Hbst.*—Berb. vulg.
163. Epilachna globosa *Schneid.*—Vit. vinif.
164. Exochomus auritus *Scrib.*—Heracl. Sphond., Achill. Millef., A. Ptarm.
165. *Halyzia quattuordecimpunctata L.* (=Coccinella quattuordecimpunctata *L.*, cf. Nos. 154 and 158).—Senec. nemor., Apocyn. androsaemif.↑
166. Micraspis duodecimpunctata *L.*—Adon. vern., Ranunc. acris, R. rep., R. bulb.
167. Rhizobius litura *F.*—Cydon. jap.
168. *Subcoccinella 24-punctata L.* (=Epilachna globosa *Schneid.*, cf. No. 163).—Vit. vinif.

O. Colydiidae.

169. *Coninomus nodifer Westw.* (=Lathridius nodifer *Westw.*).—Ranunc. Fic.
170. Corticaria gibbosa *Hbst.*—Chrysospl. alternif.

P. Cryptophagidae.

171. Antherophagus nigricornis *F.*—Senec. Jac.
172. A. pallens *Ol.*—Digit. purp.
173. A. sp.—Camp. Trach.
174. *Cis hispidus Payk.* (=Sphindus hispidus *Payk.*).—Vit. ripar.
175. Cryptophagus vini *Panz.*—Ulex europ. F±I+.

Q. Curculionidae.

176. Anthonomus rubi *Hbst.*—Rubus Id., Matric. inod.
177. Apion apricans *Hbst.*—Adoxa moschat.
178. A. columbinum *Germ.*—Adoxa moschat.
179. A. marchicum *Hbst.*—Achill. Millef.
180. A. miniatum *Germ.*—Diplopapp. amygd.
181. A. nigritarse *K.*—Potent. steril., Veron. hederif.
182. A. onopordi *K.*—Chrysospl. alternif.
183. A. striatum *K.*—Bellis per.
184. A. ulicis *Forst.*—Ulex europ. F±I±.
185. A. variipes *Germ.*—Chrysospl. alternif.
186. A. sp.—Sorb. Auc., Tarax. off.
187. Apoderus erythropterus *Zschoch.* (=A. intermedius *Ill.*).—Ulmar. pentapet.
188. Baris abrotani *Germ.*—Res. lutea.
189. Brachonyx indigena *Hbst.*—Pinus sylv.
190. Ceutorhynchidius floralis *Payk.*—Medic. lupul., Prangos ferulacea.

191. C. pumilio *Gyll.*—Teesdal. nudicaul.
192. Ceutorhynchus suturalis *Fabr.*—Vit. ripar.
193. C. sp.—Barbar. vulg., Stenophr. Thalian, Alliar. off.
194. Cionus blattariae *F.*—Verbasc. Thaps., V. Blatt., Scrophul. nod.
195. C. hortulanus *Marsh.*—Verbasc. Lychnit. flore albo, Scrophul. aquat.
196. C. scrophulariae *L.*—Scrophul. nod.
197. C. solani *F.*—Solan. Dulcam.
198. C. thapsus *F.*—Verbasc. Thaps.
199. C. verbasci *F.*—Verbasc. Thaps.
200. Coeliodes geranii *Payk.*—Geran. prat., G. sanguin.
201. Gymnetron beccabungae *L.*—Veron. Beccab.
202. *G. campanulae L.* (=Miarus campanulae *L.*, cf. No. 211).—Camp. rot., C. bonon., C. Trachel., C. persicif., C. barb.
203. G. linariae *Panz.*—Linar. vulg.
204. G. pilosum *Schönh.*—Linar. vulg.
205. G. tetrum *F.*—Verbasc. Lychn. flore albo.
206. Hypera polygoni *L.*—Calla pal. †
207. Larinus jaceae *F.*—Cirs. arv., Carduus acanth.
208. L. obtusus *Schönh.*—Cirs. arv.
209. L. senilis *F.*—Carl. acaul.
210. Magdalis violacea *L.*—Pinus sylvestr.
211. Miarus campanulae *L.* (cf. No. 202).—Geran. prat., Knaut. arv., Camp. rot.
212. M. graminis *Schönh.*—Geran. sanguin., Saxifr. granul.
213. Nanophyes lythri *F.*—Lythr. Sal. (F+I+).
214. Otiorhynchus ovatus *L.*—Camp. rot.
215. O. multipunctatus *F.*—Picea excelsa.
216. O. picipes *F.*—Cornus sang.
217. Phyllobius maculicornis *Germ.*—Sorb. Auc.
218. P. oblongus *L.*—Carum Carvi.
219. P. urticae *Deg.*—Anthrisc. sylv.
220. Rhynchites aequatus *L.*—Pyrus comm.
221. Sitona lineatus *Schönh.*—Salix rep.
222. S. puncticollis *Steph.*—Leont. aut.
223. S. sp.—Calla pal. †
224. Tychius venustus *F.*—Saroth. scop. F±I+.

R. Dermestidae.

225. *Anthrenus claviger Er.* (=A. fuscus *Ltr.*, cf. No. 226).—Arunc. sylv., Crat. Oxyac., Anthrisc. sylv., Galium bor.
226. A. fuscus *Ltr.* (cf. No. 225).—Rosa centif.
227. A. museorum *L.*—Spir. sorbif., S. salicif., Arunc. sylv., Rheum undul.
228. A. pimpinellae *F.*—Lepid. sat., Rhus Cotin., Rosa can., R. centif., Fragar. vesca, Ulmar. pentapet., Spir. sorbif., S. salicif., S. ulmif., Arunc. sylv., Crat. Oxyac., Philad. coron., Astrant. maj., Conium mac., Aegopod. Podagr., Angel. sylv., Heracl. Sphond., Daucus Car., Anthrisc. Ceref., Chaeroph. tem., Chrysanth. Leuc.
229. A. scrophulariae *L.*—Anem. ranunc., Rosa centif., Fragaria vesca, Spir. sorbif., S. salicif., S. ulmif., Arunc. sylv., Crat. Oxyac., Saxifr. granul., Ferulago montic., Anthrisc. sylv., A. Ceref., Chaeroph. tem., C. aureum, Myrrhis odor., Moloposp. Peloponn., Prangos ferulacea, Tanac. macrophyllum, Doron. Pardal., D. plantag., Myosot. alp., Veron. gentianoid., Euphorb. pal., E. salicif.
230. A. verbasci *L.*—Merc. annua.
231. A. sp.—Rheum tartar.
232. Attagenus pellio *L.*—Berb. vulg., Spir. sorbif., S. ulmif., S. salicif., Crat. Oxyac., Sorb. Auc.
233. A. schaefferi *Hbst.*—Arunc. sylv.
234. Dermestes vulpinus *F.*—Dracunc. vulg.
235. D. sp.—Amorphophall. campan.
236. Hadrotoma nigripes *F.*—Crat. Oxyac.
237. Tiresias serra *F.*—Anthrisc. sylv.

S. Elateridae.

238. Adrastus humilis *Er.*—Vit. vinif.
239. A. pallens *F.*, *Er.*—Oenanthe aquat., Valer. off.

240. Agriotes aterrimus *L.*—Sorb. Auc., Aegop. Podagr.
241. A. gallicus *Lac.*—Genista tinct. F±I±, Daucus Car., Chaeroph. hirs., Galium ver., Achill. Millef., A. Ptarm., Anthem. tinct., Cirs. arv., Antheric. Liliago.
242. A. obscurus *L.*—Daucus Car.
243. A. pallidulus *Ill.* ?—Phyteum. spic.
244. A. sputator *L.*—Lotus corn. F±I±, Daucus Car.
245. A. ustulatus *Schall.*—Vit. vinif., Genista tinct. F±I±, Heracl. Sphond., Daucus Car., Asper. cynanch., Achill. Millef., A. Ptarm., Chrysanth. Leuc., Cirs. arv., C. pal.
246. Athous haemorrhoidalis *F.*—Ranunc. lanug., Anthrisc. sylv.
247. A. niger *L.*—Aegop. Podagr., Anthrisc. sylv., Cornus sang., Anthem. arv. Chrysanth. Leuc.
248. A. subfuscus *Müll.*—Arab. aren.
249. A. vittatus *F.*—Viburn. Op.
250. Cardiophorus cinereus *Hbst.*—Spir. sorbif., S. salicif., S. ulmif.
251. C. griseus *Hbst.*—Salix rep.
252. Corymbites aeneus *L.*—Rubus frutic., Euphorb. Cypariss.
253. C. castaneus *L.*—Salix cin., S. Capr., S. aurit.
254. C. holosericeus *Oliv.*—Trif. rub., Sorbus Auc., Heracl. Sphond., Cirs. arv., Carduus acanth.
255. C. purpureus *Poda* (cf. No. 256).—Heracl. Sphond.
256. *C. haematodes F.* (=C. purpureus *Poda.*, cf. No. 255).—Tarax. off.
257. C. quercus *Oliv.*—Anthrisc. sylv.
258. C. sjaelandicus *Müll.*—Rhamn. Frang.
259. C. sulphuripennis *Germ.*—Oenoth. bienn. ? F+I+.
260. Cryptohypnus minutissimus *Germ.*—Euphorb. Cypariss.
261. C. pulchellus *L.*—Viburn. Op.
262. Dolopius marginatus *L.*—Sorb. Auc., Corn. sang.
263. Elater balteatus *L.*—Rhamn. Frang.
264. E. pomonae *Steph.*—Rhamn. Frang.
265. Lacon murinus *L.*—Rubus frutic., Spir. sorbif., S. salicif., S. ulmif., Aegop. Podagr., Anthrisc. sylv., Rheum hybrid.
266. *Limonius aeruginosus Oliv.* (=L. cylindricus *Rossi.*).—Salix rep.
267. L. bructeri *F.*—Vit. ripar.
268. L. cylindricus *Payk.*—Batrach. aquat., Ranunc. acris, R. rep., R. bulb., Rubus frutic., Sorbus Auc., Valerian. olit., Doron macrophyll., Tarax. off., Salix rep.
269. L. lythrodes *Germ.*—Vit. vinif.
270. L. parvulus *Pz.*—Teesdal. nudicaul., Sorb. Auc., Salix cin., S. Capr., S. aurit.
271. Sericus brunneus *L.*—Rhamn. Frang.
272. Synaptus filiformis *F.*—Anthrisc. sylv.

T. Eucnemidae.

273. Throscus elateroides *Heer.*—Pariet. off.

U. Histeridae.

274. Saprinus aeneus *F.*—Amorphophall. Rivieri.
275. S. nitidulus *F.*—Dracunc. vulg., Amorphophall. Rivieri.
276. S. sp.—Dracunc. vulg., Amorphophall. campan.

V. Hydrophilidae.

277. Cercyon haemorrhoidalis *F.*—Salix rep.
278. Paracercyon analis *Payk.*—Teesdal. nudicaul.

W. Lagriidae.

279. Lagria hirta *L.*—Spir. sorbif., Salix salicif., S. ulmif., Solid. fragr.

X. Meloidae.

280. Mylabris floralis *Pall.*—Centaur. rhen.
281. Nemognatha sp.—Festuca ovina.

Y. Mordellidae.

282. Anaspis flava *L.*—Anthrisc. sylv.
283. A. frontalis *L.*—Anem. nem., Rosa can., Ulmar. pentapet., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Anthrisc. Ceref., Myrrhis odor., Asper. odor., Nepeta nuda.

284. A. maculata *Fourcr.*—Spir. sorbif., S. salicif., S. ulmif.
285. A. melanostoma *Costa.*—Vit. rup., V. cand.
286. A. pulicaria *Costa.*—Vit. vinif.
287. A. ruficollis *F.*—Rosa centif.
288. A. rufilabris *Gyll.*—Anem. sylv., Stenophrag. Thalian., Caps. Bursa-past., Res. lutea., Prunus Padus., Sorb. Auc., Carum Carvi, Chaeroph. tem.
289. Mordella aculeata *L.*—Ranunc. acris, R. rep., R. bulb., Helianth. vulg., Rosa can., R. centif., Rubus frutic., Fragaria vesca, Ulmar. pentapet., Philad. coron., Daucus Car., Galium verum, G. boreale, Anthem. tinct., Tanac. corymb., Chrysanth. Leuc., Cirs. arv., Euphorb. Gerard., E. Cypariss.
290. M. fasciata *F.*—Lotus corn. F±I±, Sium latif., Heracl. Sphond., Daucus Car., Orlaya grandifl., Anthrisc. sylv., Galium verum, Achill. Millef., A. Ptarm., Anthem. tinct., Chrysanth. Leuc., Cirs. arv., Crep. vir.
291. *M. pumila Gyll.* (=Mordellistena pumila *Gyll.*, cf. No. 294).—Carum Carvi, Bupleur. falc., Anthrisc. sylv.
292. *M. pusilla Dej.* (= Mordellistena parvula *Gyll.*)—Ranunc. acris, R. rep., R. bulb., Carum Carvi.
293. Mordellistena abdominalis *F.*—Crat. Oxyac.
294. M. pumila *Gyll.* (cf. No. 291).—Anem. nem., Myrrhis odor., Euphorb. Gerard.

Z. Nitidulidae.

295. Brachypterus gravidus *Ill.*—Ranunc. rep., Stell. gramin., Anthrisc. sylv., Linar. vulg.
296. B. urticae *F.*—Urtica urens.
297. Cercus pedicularis *L.*—Ligustr. vulg.
298. C. rufilabris *Ltr.*—Daucus Car., Achill. Millef.
299. Cychramus luteus *Oliv.*—Rubus Id., Ulmar pentapet.
300. Epuraea aestiva *L.*—Caltha pal., Anthrisc. sylv., Chaeroph. tem., Salix rep., Narc. Pseudo-Narc.
301. E. melina *Er.*—Ulmar. pentapet., Pimp. Saxifr.
302. E. sp.—Alliar. off., Sorb. Auc., Anthrisc. sylv., Myrrhis odor.
303. *Meligethes aeneus F.* (=M. brassicae *Scop.*, cf. No. 304).—Ranunc. rep., R. lanugin., Schiever. podol., Cak. marit., Hyper. perfor., H. tetrapt., Erod. Cicut., Medic. lupul., Potent. Anser., Ulmar. pentapet., Sorb. Auc., Parnassia pal., Anthrisc. sylv., Chaeroph. tem., Myrrhis odor., Knaut. arv., Aster Tripol., Pulic. dysent., Doron. Pardal., Senec. palud., Phyteum. spic., Origan. vulg., Salix rep.
304. M. brassicae *Scop.* (cf. No. 303).—Ranunc. acris, R. rep., R. bulb., Alliar. off., Brass. nig., Crambe marit. (F+I+), Raphan. Raph., Vit. vinif., V. ripar., V. ariz.
305. M. coracinus *Sturm.*—Ranunc. acris, R. rep., R. bulb., Viola can., Anthrisc. sylv.
306. M. lepidii *Mill.*—Lepid. Draba.
307. M. obscurus *Er.*—Pulic. dysent.
308. Meligethes pedicularius *Gill.*—Vit. ripar.
309. Meligethes picipes *Sturm.*—Ranunc. Fic., Caltha pal., Cochlear. off., Oxalis Acetos., Ulex europ. F±I+, Parnass. pal., Daucus Car., Succ. prat., Eupat. cannab., Tussil. Farf., Pulic. dysent., Tarax. off., Prim. vulg. F±I+.
310. M. symphyti *Heer.*—Symphyt. off.
311. M. tristis *Sturm.*—Echium vulg.
312. M. viridescens *F.*—Crambe marit. (F+I+), Medic. sat. F±I±, Rubus frutic., Ulmar. pentap., Succ. prat., Pulic. dysent., Centaur. nigra, Jas. mont.
313. M. sp.—Thalictr. aquilegif., Pulsat. vulg., Anem. nemor., Adon. vern., Ranunc. acris, R. rep., R. bulb., R. auric., R. Fic., Caltha pal., Nuph. lut., Papav. Rhoeas, P. somnif., P. dubium, Glaucium flav., Chelidon. maj., Nasturt. off., N. amphib., N. sylv., Barbar. vulg., Arab. paucifl., Cardam. prat., Stenophr. Thalian., Alliar. off., Erysim. crepidifol., Brass. oler.. B. Rapa., Sinap. arv., Kernera saxat., Cochlear. Armorac., C. off., Camel. sat., Biscut. laevig., Isat. tinctor., Cak. marit., Crambe marit., Raphan. Raph., R. sat., Viola odor., V. tric. arv., Viscar. vulg., Moehring. trinerv., Stellar. gramin., S. Holost., S. med., S. nem., Malach. aquat., Cerast. arv., Malva sylv., Geran. Robert., Oxalis Acetos., Impat. Noli-tang. F±I±, Saroth. scop. F±I±, Ulex europ. F±I±, Cytis. Lab. F±I±, Ornithop. sat., Persica vulg., Prunus spin., P. Padus, Rosa can., R. centif., Rubus frutic., R. caes., Geum riv.,

Fragaria vesca, Potent. Anser., P. rept., P. arg., P. verna., P. frutic., Ulmar. pentapet., Spir. sorbif., S. salicif., S. ulmif., Arunc. sylv., Pyrus comm., Sorb. Auc., Epil. parvifl., Lythr. Sal. (F+I+), Philad. coron., Saxifr. granul., Sanic. europ., Conium mac., Pimpin. Saxifr., Angel. sylv., Peuced. pal., Aneth. graveol., Heracl. Sphond., Anthrisc. sylv., A. Ceref., Cornus sang., Viburn. Op., Asper. odor., Valer. dioica, Valerianella olit., Knaut. arv., Tussil. Farf., Bellis per., Achill. Millef., Matric. Chamom., Chrysanth. Leuc., Doron. austr., D. caucas., Senec. Jac., S. vern., Tragopog. prat., Scorz. hum., Tarax. off., Lact. mur., Crep. bien., Camp. rot., C. bonon., C. Trach., C. persicif., Ligustr. vulg., Apocyn. androsaemif. F±I+, Menyanth. trif., Phacelia tanacetif., Conv. arv., C. sp., Symphyt. off., Myosot. alp., Dat. Stram., Verbasc. nigr., Linar. vulg., Digit. purp., Veron. Cham., V. hederif., Mentha aquat., Nepeta nuda, N. Glechoma? F±I+, Stach. pal. F±I±, Marrub. vulg. F±I±, Trient. europ., Prim. veris, Statice Lim., Plant. med., Polygon. Bist., Salix cin., S. Capr., S. aurit., Calla pal., Cyprip. Calc. F±I±, Narc. Pseud.-Narc. F±I± (F+I+), Gagea lutea, G. arv., Lilium candidum, Brodiaea ixioid., Hyac. orient.

314. Pria dulcamarae *Ill.*—Solan. Dulcam.
315. Thalycra fervida *Gyll.* (cf. No. 316).—Heracl. Sphond.
316. *Thalycra sericea Sturm.* (=T. fervida *Gyll.*, cf. No. 315).—Cornus sang.

AA. Oedemeridae.

317. *Anoncodes rufiventris Scop.* (=Nacerdes rufiventris *Scop.*).—Siler. tril.
318. Asclera coerulea *L.*—Crat. Oxyac.
319. Chrysanthia viridis *Schmidt.*—Aegop. Podagr., Galium Mollugo.
320. C. viridissima *L.*—Siler tril.
321. Nacerdes austriaca *Ggb.*—Vit. vinif., V. ripar., V. rup., V. candic.
322. N. melanura *L.*—Cak. marit.
323. N. viridipes *Schmidt.*—Lepid. Draba.
324. Oedemera coerulea *L.* (=O. nobilis *Scop.*).—Sedum album.
325. O. flavescens *L.*—Sedum album, Peuced. Oreosel., Chaeroph. hirs., Galium sylv., Anthem. tinct.
326. O. flavipes *F.*—Sedum album, Peuced. Oreosel., Knaut. arv., Hypoch. rad.
327. O. lurida *Marsh.*—Vit. ripar., Peuced. Oreosel., Hierac. Pilos.
328. *O. marginata F.* (=O. subulata *Oliv.*, cf. No. 330).—Tanac. corymb., Plant. med.
329. O. podagrariae *L.*—Dianth. Carthus., Ulmar. Filip., Aegop. Podagr., Peuced. Oreosel., Galium Mollugo, G. verum, Achill. Millef., A. Ptarm., Chrysanth. Leuc., Cirs. arv.
330. O. subulata *Oliv.* (cf. No. 328).—Peuced. Oreosel.
331. O. virescens *L.*—Thalictr. minus, Ranunc. acris, R. rep., R. bulb., Papaver Rhoeas, Helianth. vulg., Stell. Holost., Rubus frutic., Aegopod. Podagr., Peuced. Oreosel., Heracl. Sphond., Bellis per., Tanac. corymb., Senec. Jac., Hypoch. rad., Jas. mont., Conv. arv., Echium vulg., Antheric. ramos.

BB. Phalacridae.

332. Olibrus aeneus *F.*—Pyrus comm., Chrysospl. alternif.
333. O. affinis *Sturm.*—Moehr. trinerv.
334. O. bicolor *F.*—Knaut. arv.
335. Phalacrus corruscus *Panz.*—Solid. canad., Bromus mollis.

CC. Scarabaeidae.

336. Aphodius contaminatus *Hbst.*—Potent. sylv.
337. A. melanostictus *Schmidt.*—Arum pictum.
338. Cetonia aurata *L.*—Thalictr. aquilegif., T. glaucophyll., Magnol. grandifl., Viola tric. alp., V. tric. versic. F±I+, Rosa can., R. centif., Ulmar. pentapet., U. Filip., Spir. sorbif., S. salicif., S. ulmif., S. digit., Crat. Oxyac., Sorb. Auc., Aegop. Podagr., Libanot. mont., Aneth. graveol., Heracl. Sphond., H. sibir., H. pubesc., Chaeroph. aureum, C. hirs., Myrrhis odor., Moloposp. Peloponn., Sambuc. niger, Galium verum, Valer. offic., V. altiss., V. allariif., Centrant. ruber F±I+, C. angustif., Solid. laterifl., Achill. Millef., A. Ptarm., Tanac. macrophyll., Chrysanth. Leuc., Echinops exalt., Cirs. arv., C. oler., Centaur. caloceph., C. rup., Ligustr. vulg., Rheum undul., Euphorb. pal., Tulipa Didieri, Trill. sessile.
339. C. floricola *Hbst.*—Sorb. Auc.

340. C. floricola *Hbst.*, var. metallica *F.* (cf. No. 342).—Anthrisc. sylv.
341. *C. hirtella L.* (=Oxythyrea funesta *Poda.*, cf. Nos. 343, 350, and 353).—Ranunc. bulb.
342. *C. metallica F.* (=C. floricola *Hbst.*, var. metallica *F.*, cf. No. 340).—Rosa can.
343. *C. stictica L.* (auct.) (=Oxythyrea funesta *Poda.*, cf. Nos. 341, 350, and 353).—Papaver somnif.
344. C. sp.—Camp. medium, Dracunc. canar.
345. Gnorimus nobilis *L.*—Aegop. Podagr., Sambuc. niger, Chrysanth. Leuc.
346. Hoplia argentea *Poda.*—Aegop. Podagr., Fraxin. Orn.
347. H. philanthus *Sulz.*—Aegop. Podagr., Heracl. Sphond., Knaut. arv.
348. H. praticola *Duft.*—Anthrisc. sylv.
349. Melolontha vulgaris *F.*—Rosa centif., Sorb. Auc.
350. Oxythyrea funesta *Poda.* (cf. Nos. 343 and 353).—Magn. grandifl., Papaver Rhoeas, Vit. vinif., V. ripar., Heracl. Sphond.
351. O. hirta *Pota.*—Heracl. Sphond.
352. O. squalida *Scop.*—Cist. salviif.
353. *O. stictica L.* (=Oxythyrea funesta *Poda.*, cf. Nos. 341, 343, and 350).—Rosa can., Crat. Oxyac., Siler. tril., Sambuc. niger, Viburn. Op.
354. O. sp.—Dracunc. canar.
355. Phyllopertha horticola *L.*—Anem. sylv., Barbar. vulg., Brass. nig., Sinap. arv., Cak. marit., Vit. vinif., Rosa can., R. pimpinellif., R. centif., Rubus frutic., Spir. sorbif., S. salicif., S. ulmif., S. digit., Philad. coron., Aegop. Podagr., Heracl. sibir., Sambuc. niger, Viburn. Op., Hier. Pilos., Rheum tartar.
356. Rhizotrogus solstitialis *L.*—Valer. Phu.
357. Trichius abdominalis *Mén.*—Viburn. Op., Rheum Tartar.
358. T. fasciatus *L.*—Clemat. recta, Thalictr. aquilegif., Rubus frutic., Ulmar pentapet., U. Filip., Spir. sorbif., Sp. salicif., S. ulmif., Conium mac., Aegop. Podagr., Pimpin. Saxifr., Sium latif., Oenanthe fistul., Angel. sylv., Heracl. Sphond., Daucus Car., Anthrisc. sylv., Sambuc. niger, Viburn. Op., Knaut. arv., Chrysanth. Leuc., Cirs. arv., Carduus acanth., Polygon. Bist.

DD. Silphidae.

359. Necrophorus vespillo *L.*—Aneth. graveol., Achill. Millef.

EE. Staphylinidae.

360. Gen. et sp. ?—Arum ital., Scirpus lacustris.
361. Anthobium abdominale *Grav.*—Saroth. Scop. F±I+.
362. A. florale *Grav.*—Saroth. scop. F±I+.
363. A. minutum *F.*—Ranunc. Flamm., R. acris, R. rep., R. bulb.
364. *A. (Eusphalerum) primulae Fauv.* (=A. triviale *Er.*).—Prim. vulg. F±I+.
365. A. robustum *Heer.* (=*A. excavatum Er.*).—Prim. integrif.
366. A. sorbi *Gyll.*—Phyteum. spic.
367. A. torquatum *Marsh.*—Medic. lupul., Lotus corn. F±I+.
368. A. sp.—Geran. Robert., Camp. rot., Luzula nivea.
369. Anthophagus spectabilis *Heer.*—Polygon. Bist.
370. Creophilus maxillosus *L.*—Dracunc. vulg.
371. Lathrimaeum atrocephalum *Gyll.*—Chrysospl. alternif.
372. Omalium florale *Payk.*—Cardam. prat., Cerast. arv., Oxal. Acet., Tussil Farf., Pulmon. off., Prim. elat. ↓
373. Oxytelus nitidulus *Grav.*—Arum pictum.
374. O. sp.—Amorphophall. campan.
375. Philonthus sp.—Valerian. olit.
376. Quedius boöps *Grav.*—Achill. Millef.
377. Staphylinus *sp.*—Hepatica triloba.
378. Tachinus fimetarius *Grav.*—Carum Carvi.
379. Tachyporus chrysomelinus *L.*—Chrysospl. alternif.
380. T. hypnorum *F.*—Caltha pal., Potent. Anser., Salix purp.
381. T. obtusus *L.*—Alliar. off., Daucus Car., Phacelia tanacetif.
382. T. solutus *Er.*—Ranunc. acris, R. rep., R. bulb., Carum Carvi.
383. T. sp.—Potent. Anser.
384. Xantholinus linearis *Ol.*—Solid. graminif.

FF. Tenebrionidae.

385. Microzoum tibiale *F.*—Sorb. Auc.

GG. Telephoridae.

386. Anthocomus equestris *F.*—Tommas. verticill.
387. A. fasciatus *L.*—Hesper. matron., Lepid. sat., Rosa can., R. centif., Carum Carvi, Heracl. Sphond., Anthrisc. sylv., A. Ceref., Myosot. alp., Plant. med.
388. Axinotarsus pulicarius *F.*—Heracl. Sphond., Anthrisc. sylv.
389. Cantharis albomarginata *Märk.*—Habenar. conop.
390. C. alpina *Payk.*—Heracl. Sphond.
391. C. fulva *Scop.* (=*Telephorus melanurus F.*, cf. Nos. 395, 426, 427, and 434).—Spir. sorbif., S. salicif., S. ulmif., Parnass. pal., Conium mac., Sium latif., Daucus Car., Galium Mollugo, Achill. Millef.
392. C. fulvicollis *F.* (cf. No. 431).—Aegop. Podagr.
393. C. fusca *L.* (cf. No. 432).—Daucus Car., Anthrisc. sylv., Rheum tart., Camass. Fraseri, Carex Fraseri.
394. C. haemorrhoidalis *F.*—Crat. Oxyac.
395. *Cantharis melanura F.* (=C. fulva *Scop.*, cf. Nos. 391, 426, 427, and 434).—Aegop. Podagr.
396. C. nigricans *Müll.*—Aegop. Podagr.
397. C. rustica *Fall.* (cf. No. 438).—Isat. tinctor., Rubus frutic., Crat. Oxyac.
398. C. testacea *L.* (cf. No. 430).—Crat. Oxyac.
399. C. tristis *F.*—Picea excelsa.
400. C. sp.—Crat. Oxyac., Euphorb. Cypariss.
401. Danacea nigritarsis *Küst.*—Vit. vinif.
402. D. pallipes *Pz.*—Dianth. Carthus., Malva sylv., Rosa rubigin., Daucus Car., Orlaya grandifl., Asper. cynanch., Tanac. corymb., Verbasc. Lychnit. flore albo, Allium rot.
403. Dasytes alpigradus *Kiesw.*—Potent. aurea, Chaeroph. Villarsii.
404. *Dasytes flavipes F.* (=D. plumbeus *Müll.*, cf. No. 407).—Anem. sylv., Geran. Robert., Impat. Noli-tang. F±I±, Rubus frutic., Fragaria vesca, Potent. frutic., Spir. sorbif., S. salicif., S. ulmif., Sorbus scand., Aegop. Podagr., Carum Carvi, Pimpin. Saxifr., Peuced. Oreosel., P. pal., Tanac. corymb., Chrysanth. Leuc., Cirs. heteroph., Lactuca per., Pyrola min., Phacelia tanacetif., Polemon. coer., Nepeta nuda, Antheric. ramos.
405. D. niger *L.*—Rubus Id., Aegop. Podagr., Campan. persicif.
406. D. obscurus *Gyll.*—Pinus sylv.
407. D. plumbeus *Müll.* (cf. No. 404).—Alyss. mont., Lepid. sat., V. vinif., V. ripar., V. cordif., V. rup., Geum urb., Anthrisc. sylv.
408. D. subaeneus *Schh.*—Orlaya grandifl., Asper. cynanch.
409. D. sp.—Cerast. arv., Prunus Padus, Rosa centif., Philad. coron., Bryonia dioica, Asper. odor., Digit. purp., Melamp. nemor.
410. Dictyoptera rubens *Gyll.* (cf. No. 411).—Aegop. Podagr.
411. *D. sanguinea Scop.* (=D. rubens *Gyll.*, cf. No. 410).—Galium sylv., Cirs. arv.
412. Dolichosoma lineare *Rossi.*—Galium Mollugo.
413. Ebaeus thoracicus *Oliv.*—Asper. cynanch.
414. Haplocnemus pini *Redt.* and Var. serratus *Redt.*—Pinus sylv.
415. H. tarsalis *Sahlb.*—Pinus sylv.
416. *Henicopus hirtus L.* (=H. pilosus *Scop.*).—Festuca ovina.
417. Malachius aeneus *L.*—Ranunc. acris, R. rep., R. bulb., Vit. ripar., Geran. pyren., Sorb. Auc., Toril. Anthrisc., Anthrisc. sylv., A. Ceref., Chrysanth. Leuc., Plant. med.
418. M. bipustulatus *L.*—Anem. sylv., Ranunc. acris, R. rep., R. bulb., Cochlear. Armorac., Lepid. sat., Cerast. arv., Vicia Faba F±I+, Rubus frutic., Fragaria vesca, Ulmar. pentapet., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Philad. coron., Aegop. Podagr., Carum Carvi, Anthrisc. sylv. Chaeroph. hirs., Knaut. arv., Cichor. Int., Tarax. off., Polygon. Bist.
419. M. elegans *Oliv.*—Vit. vinif., V. ripar., V. rup., V. ripar. vinif., V. ripar. labrusca, Crat. Oxyac., Tarax. off.
420. M. geniculatus *Germ.*—Vit. vinif., V. ripar.
421. *M. gracilis Mill.* (=M. affinis *Mén.*).—Tarax. off.
422. M. viridis *F.*—Conv. arv., Brachypod. pinnat.
423. M. sp.—Sonchus arv., Alopec. genicul.
424. Psilothrix cyaneus *Ol.* (=*Dolichosoma nobilis Rossi*).—Cak. marit., Cirs. arv., C. lanceol., Leont. aut., Tarax. off., Ammophila aren.
425. *Rhagonycha denticollis Schumm.* (=Cantharis denticollis *Schumm.*).—Chaeroph. Villarsii.

426. *R. fulva Scop.* (=Cantharis fulva *Scop.*, cf. Nos. 391, 395, 427, and 434).—Pimpin. Saxifr., Listera ovata.
427. *R. melanura F.* (=Cantharis fulva *Scop.*, cf. Nos. 391, 395, 426, and 434).—Peuced. Oreosel., Aneth. graveol., Anthrisc. sylv., Cirs. arv., Listera ovata F±I+.
428. *R. nigripes Redt.* (=Cantharis nigripes *Redt.*)—Chaeroph. Villarsii.
429. *R. terminalis Redt.* (=Cantharis terminalis *Redt.*).—Anthrisc. sylv.
430. *R. testacea L.* (=Cantharis testacea *L.*, cf. No. 398).—Anthrisc. sylv.
431. *Telephorus fulvicollis F.* (=Cantharis fulvicollis *F.*, cf. No. 392).—Anthrisc. sylv.
432. *T. fuscus L.* (=Cantharis fusca *L.*, cf. No. 393).—Aegop. Podagr., Carum Carvi, Heracl. Sphond., Anthrisc. sylv., Moloposp. Peloponn.
433. *T. lividus L.* (=Cantharis livida *L.*).—Carum Carvi, Heracl. Sphond., Anthrisc. sylv.
434. *T. melanurus F.* (=Cantharis fulva *Scop.*, cf. Nos. 391, 395, 426, and 427).—Pimpin. Saxifr., Sium latif., Angel. sylv., Peuced. pal., Heracl. Sphond., Daucus Car., Achill. Millef., A. Ptarm., Cirs. arv.
435. *T. obscurus L.* (=Cantharis obscura *L.*).—Anthrisc. sylv.
436. *T. pellucidus F.* (Cantharis pellucida *F.*).—Carum Carvi, Cornus sang.
437. *T. rufus L.* (=Cantharis rufa *L.*).—Anthrisc. sylv.
438. *T. rusticus Fall.* (=Cantharis rustica *Fall.*, cf. No. 397).—Carum Carvi, Anthrisc. sylv., Ornithogal. Bouchean.

HH. Trixagidae.

439. *Byturus fumatus F.* (=Trixagus fumatus *F.*, cf. No. 440).—Anem. sylvest. Ranunc. acris, R. rep., R. bulb., R. lanug., Actaea spic., Alliar. off., Geran. pyren., Rubus frutic., R. Id., Geum urb., Spir. sorbif., S. salicif., S. ulmif., Sorbus Auc., Anthrisc. sylv., Corn. sang., Aegop. Podagr.
440. Trixagus fumatus *F.* (=*Byturus fumatus F.*, cf. No. 439).—Rubus Id., Aegop. Podagr.

III. DIPTERA

A. Asilidae.

441. Asilus albiceps *Mg.*—Trif. arv. ♀ and ♂ F+I+.
442. Dioctria atricapilla *Mg.*—Ranunc. acris, R. rep., R. bulb., Anthrisc. sylv.
443. D. flavipes *Mg.*—Aegop. Podagr., Knaut. arv., Centaur. Cyan.
444. D. oelandica *L.*—Rubus frutic.
445. D. reinhardi *Wiedem.*—Heracl. Sphond.
446. Ispogon brevirostris *Mg.*—Pimpin. Saxifr.
447. Laphria flava *L.*—Vacc. Myrt.
448. Lasiopogon cinctus *F.*—Ranunc. mont.

B. Bibionidae.

449. Bibio hortulanus *L.*—Anem. sylv., Cochlear. Armorac., Isat. tinctor., Bunias orient., Acer Pseudoplat., Spir. sorbif., S. salicif., S. ulmif., Carum Carvi, Ferulago monticola, Anthrisc. sylv., A. Cerefol., Chaerophyll. aureum, C. hirsut., Moloposperm. Peloponnes., Polygon. Bist., Euphorb. palustr., E. pilosa.
450. B. johannis *L.*—Salix cin., S. capr., S. aurit.
451. B. laniger *Mg.*—Viburn. Lant.
452. B. lepidus *Löw.*—Mentha aquat.
453. B. marci *L.*—Ranunc. acris, R. rep., Crat. Oxyac., Anthrisc. sylv., Tarax. off., Euphorb. palustr., Salix cin., S. Capr., S. aurit., S. rep.
454. B. pomonae *F.*—Senec. Jacob., Hypoch. radic.
455. B. sp.—Anthrisc. sylv.
456. Dilophus albipennis *Mg.*—Tarax. off.
457. D. femoratus *Mg.*—Armer. elong.
458. D. vulgaris *Mg.*—Ranunc. acris, R. rep., Alliar. off., Moehr. trinerv., Crat. Oxyac., Pyrus Malus, Parnass. pal., Peuced. pal., Anthrisc. sylv., Solidago juncea, Achill. Millef., Tarax. off., Call. vulg., Armer. elong., Euphorb. palustr., Salix cin., S. Capr., S. aurit., S. amygd., S. rep.
459. D. sp.—Valerian. olitor., Senec. Jacob.
460. Scatopse brevicornis *Mg.*—Myos. minim., Medic. lupul., Parnass. pal., Matricar. inod., Mentha aquat.

461. S. inermis *Ruthe.* (=S. soluta *Loew.*).—Aristol. Clemat. F+I+.
462. S. nigra *Mg.*—Aristol. rotund. F+I+.
463. S. notata *L.*—Stell. med., Salix Capr., S. rep.

C. Bombyliidae.

464. Anthrax flava *Mg.*—Hyper. perfor., Aegop. Podagr., Bupleur. falcat., Pastin. sat., Heracl. Sphond., Daucus Car., Galium Mollugo, G. verum, Cirs. arv., Thym. Serp.
465. A. hottentotta *L.*—Nasturt. sylv., Heracl. Sphond.
466. A. maura *L.*—Hyper. perfor., Peuced. Cervar., Aneth. graveol., Galium sylvat., Convolv. arv.
467. A. morio *L.*—Alchem. acutiloba, Tanacet. corymbos.
468. A. paniscus *Rossi.*—Chaerophyll. Villarsii, Knaut. arv.
469. A. sp.—Sagin. nod., Thym. Serp.
470. Argyromoeba sinuata *Fall.*—Lepid. sat., Silene rup., Hyper. perfor., Galium sylvat., Carduus deflorat.
471. Bombylius canescens *Mikan.*—Stell. Holost., Hyper. perfor., Vicia sep., Sedum album, Chrysanth. Leucanth., Hierac. Pilos., Convolv. arv., Veron. Cham., Salvia prat. F±I±, Origan. vulg., Thym. Serp., Nepeta Catar., Galeops. Ladan. F±I+.
472. B. discolor *Mikan.*—Anem. ranunculoid., Corydal. cava F±I+, C. solida F±I+, Cardam. prat., Viola odor. F+I+, V. sylvat., V. canina ? F+I+, Vinca min., Pulmon. off., Nepeta Glechoma (F+I+), Prim. elat. F±I+ (F+I+), P. Veris F±I+ (F+I+).
473. B. major *L.*—Corydal. cava F±I+, C. solida F±I+, Cardam. prat., Viola can. F+I+, Stell. Holost., Prunus spin., Pyrus Malus, Myrrhis odor., Tussil. Farf., Syringa vulg., Vinca minor, Anchusa off., Pulmon. off., Myosot. intermed., Nepeta Glechoma (F+I+), Lam. purp. F+I+, Prim. elat. ? F±I±, Salix cin., S. Capr., S. aurit., S. rep.
474. B. medius *L.*—Prim. vulg. F+I+.
475. B. minor *L.*—Silene rup., Centaur. rhen., Veron. off., Thym. Serp.
476. B. sp.—Calamintha alpina, Ballota nigra F±I+, Ajuga rept. F±I+, Hyacinth. amethyst.
477. Exoprosopa capucina *F.*—Knaut. arv., Succ. prat., Anthem. tinct., Leont. aut., Achill. Millef., A. Ptarm., Jas. mont., Thym. Serp.
478. E. cleomene *Egg.*—Buphthalm. salicif.
479. E. picta *Mg.*—Asperula cynanch.
480. Lomatia beelzebub *F.*—Chrysanth. Leucanth., Anthem. tinct.
481. Phthiria canescens *Loew.*—Cak. marit.
482. P. gaedii *Mg.*—Centaur. Scab.
483. Ploas grisea *F.*—Orlaya grandifl.
484. Systoechus sulphureus *Mikan.*—Malva mosch., Linum cathart., Medic. falc., Trif. prat., Potent. sylv., Asperula cynanchica, Galium Mollugo, Centaur. rhen., Leont. aut., L. hastil., Camp. rot., Call. vulg., Convolv. arv., Verbasc. nigr., Euphras. off., Thym. Serp., Calamintha Acin.

D. Cecidomyidae.

485. Cecidomyia (?) atricapilla *Rond.*—Aristol. rotunda F+I+.
486. C. sp.—Myosur. minim., Chrysospl. alternifol., Tussil. Farf.

E. Chironomidae.

487. Ceratopogon aristolochiae *Rond.*—Aristol. Clemat. F+I+, A. Sipho. F+I+.
488. C. lucorum *Mg.*—Aristol. Clemat. F+I+. A. altiss. F+I+.
489. C. minutus *Mg.*—Aristol. rotunda F+I+.
490. C. niger *Winn.*—Daucus Car.
491. C. pennicornis *Zett.*—Aristol. Clemat. F+I+.
492. C. pictellum *Rond.*—Arum ital. F+I+.
493. C. sp.—Spir. sorbif., S. salicif., S. ulmif., Anthrisc. sylv., Armer. elong., Aristol. Clemat. F+I+.
494. Chironomus byssinus *Schr.*—Myosur. minim., Arum ital. F+I+.
495. C. gracilis *Macq.* ?—Aristol. pall. F+I+.
496. C. (*Cricotopus*) tremulus *L.*—Angel. sylv.
497. C. sp.—Medic. lupul., Chrysosplen. oppositifol., Angel. sylv., Anthrisc. sylv., Petasit. off., Aristol. clemat. F+I+, Calla pal. F+I+.
498. Corynoneura sp.—Ulmar. pentapet.

499. *Cricotopus sp.* (=Chironomus sp.).—Achill. Millef.
500. Metriocnemus sp.—Hedera Helix.
501. Orthocladius sp.—Hedera Helix.

F. Conopidae.

502. Conops capitatus *Loew.*—Pastin. sat.
503. C. flavipes *L.*—Lotus corn. F±I±, Galium verum, Chrysanth. Leucanth., Cirs. arv., Centaur. Jacea, Achill. Millef., A. Ptarm., Phlox panicul., Thym. Serp.
504. C. quadrifasciatus *Deg.*—Aegop. Podagr., Pimpin. Saxifr., Heracl. Sphond., Knaut. arv., Valer. off., Chrysanth. Leucanth., Cirs. arv., C. pal., Carduus crisp., Mentha sylv.
505. C. scutellatus *Mg.*—Valer. off., Senec. nemor., S. pal., Carduus acanth., Achill. Millef., A. Ptarm.
506. C. vesicularis *L.*—Vacc. Myrt.
507. Dalmannia punctata *F.*—Sinap. arv., Cerast. arv., Geran. molle, Veron. off., Salvia prat. F±I±.
508. Myopa buccata *L.*—Sinap. arv., Erod. Cicut., Medic. lupul. F+I+, Trif. rep. (F+I+), Salix cin., S. Capr., S. aurit., S. rep.
509. M. fasciata *Mg.*—Knaut. arv., Centaur. rhen., Jas. mont.
510. M. occulta *Mg.*—Heracl. Sphond.
511. M. polystigma *Rond.*—Spir. sorbif., S. salicif., S. ulmif., Origan. vulg.
512. M. testacea *L.*—Alyss. calyc., Geran. molle, Genista tinct. F±I±, Medic. lupul. F+I+, Trif. rep. (F+I+), Lotus corn. F±I+, Sorbus Auc., Thym. Serp., Salix cin., S. Capr., S. aurit., Tulipa sylv.
513. M. variegata *Mg.*—Buphthalm. salicif., Origan. vulg.
514. M. sp.—Tussil. Farf., Anthem. tinct., Myosot. sylvat.
515. Occemyia atra *F.*—Geran. dissect., Knaut. sylvat., Crep. vir., Hierac. umbell.
516. Physocephala nigra *Deg.*—Centaur. rhen., Jas. mont., Vacc. Myrt.
517. P. rufipes *F.*—Nasturt. off., Melilot. albus F+I+, Rubus frutic., Spir. sorbif., S. salicif., S. ulmif., Knaut. arv., Cirs. arv., C. lanceol., Carduus acanth., Jas. mont., Vacc. Myrt., Echium vulg., Melampyr. arv. F±I±, Origan. vulg., Thym. Serp.
518. P. truncata *Loew.*—Centaur. rhen.
519. P. vittata *F.*—Knaut. arvens., Centaur. Jac., C. rhen., Achill. Millef., A. Ptarm., Jas. mont., Echium vulg.
520. Sicus ferrugineus *L.*—Genista tinct. F±I±, Trif. prat., Rubus frutic., Potent. frutic., Aegop. Podagr., Valer. off., Knaut. arv., K. sylvat., Scab. Columb., Chrysanth. Leucanth., Cirs. pal., Centaur. Jacea, C. nigra, Cichor. Intyb., Leont. aut., L. hastil., Hypoch. radic., Sonchus arv., Crep. vir., Hierac. Pilos., H. umbell., Jas. mont., Echium vulg., Origan. vulg., Thym. Serp., Salix cin., S. Capr., S. aurit.
521. Zodion cinereum *F.*—Heracl. Sphond., Knaut. arv., Achill. Millef., Senec. Jacob.
522. Z. notatum *Mg.*—Jas. mont.

G. Culicidae.

523. Anopheles sp.—Mentha aquat.
524. Culex pipiens *L.*—Rhamnus Frang., Lopezia coron. F+I+.

H. Dolichopidae.

525. Dolichopus aeneus *Deg.*—Ranunc. acris, R. rep., R. bulb., Carum Carvi, Sium latif., Anthrisc. sylv., Galium Mollugo, G. verum.
526. D. brevipennis *Mg.*—Anthrisc. sylv.
527. D. plumipes *Scop.*—Parnass. pal., Achill. Millef.
528. D. sp.—Potent. sylv., Anthrisc. sylv., Aster Tripol.
529. Gymnopternus chaerophylli *Mg.*—Aegop. Podagr.
530. G. germanus *Wied.*—Conium macul., Toril. Anthrisc.
531. G. nobilitatus *L.*—Matric. Chamom.
532. Neurigona quadrifasciata *F.*—Linnaea boreal. (?)

I. Empidae.

533. Cyrtoma spuria *Fall.*—Caltha pal., Valerian. olit., Veron. Cham.
534. Empis aestiva *Loew.*—Camp. med.

535. Empis chioptera *Fall.*—Fragaria vesca, Hotton. pal. F+I+.
536. E. ciliata *F.*—Stell. Holost., Crat. Oxyac., Tarax. off.
537. E. decora *Mg.*—Orchis mac. F+I+.
538. E. fallax *Egg.*—Anthrisc. sylv.
539. E. hyalipennis *Fall.*—Oenoth. bienn. × O. muric.
540. E. livida *L.*—Ranunc. lanugin., Papaver Rhoeas, Chelidon. majus, Nasturt. off., N. amphib., N. sylv., Polyg. vulg., Stell. gramin., Cerast. arv., C. triv., Hyper. perfor., Linum cathart., Vicia Cracca F±I±, Prunus Padus, Rubus frutic., Fragaria vesca, Potent. Anser., Crat. Oxyac., Pyrus Malus, Sorbus Auc., Epil. angust., Bryon. dioica, Aegop. Podagr., Oenanthe fistul., Heracl. Sphond., Orlaya grandifl., Cornus sang., Asperula cynanch., Valer. off., Knaut. arv., Succ. pratens., Bellis per., Matric. Chamom., Tanacet. corymbos., Senec. Jacob., Cirs. arv., C. palustre, Carduus crisp., Centaur. Jacea, C. Cyanus, Picris hieracioid., Hypoch. radic., Tarax. off., Achill. Millef., A. Ptarm., Jas. mont., Ligustr. vulg., Asclep. syr. F+I+, Erythr. Centaur., Convolv. arv., C. sep., Veron. off., V. Anagall., Mentha aquatica, Origan. vulg., Thym. Serp., T. vulg., Marrub. vulg. F±I±, Hotton. pal. F+I+, Polygon. Bist., Butom. umbell., Orchis mac. F+I+, Antheric. ramos., Allium Cepa.
541. *E. Nigricans Mg.* (=E. rustica *Fall.*, cf. No. 546).—Alliar. off.
542. E. opaca *F.*—Caltha pal., Cardam. prat., Stell. Holost., Cerast. arv., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Lonic. Xylost. (F+I+), Knaut. arv., Bellis per., Tarax. off., Myosot. sylvat., M. palustr., Salix amygd.
543. E. pennaria *Fall.*—Oenoth. bienn. × O. muric.
544. E. pennipes *L.*—Valerian. olit., Hotton pal. F+I+, Orchis mac. F+I+.
545. E. punctata *F.*—Cochl. Armor., Medic. lupul., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Sorb. Auc., Aegop. Podagr., Anthrisc. sylv., Myrrhis odor., Tarax. off., Cyprip. Calc. F±I±.
546. E. rustica *Fall.* (cf. No. 541).—Batrach. aquat., Nasturt. off., Cerast. arv., Prunus spin., P. Padus, Sorb. Auc., Epil. angust., Oenanthe fistul., Valer. off., Chrysanth. Leucanth., Centaur. Jacea, Mentha aquatica, Origan. vulg., Hotton. pal. F+I+.
547. E. stercorea *L.*—Ranunc. acris, R. rep., R. bulb., Carum Carvi, Anthrisc. sylv., Myrrhis odorat.
548. E. tessellata *F.*—Ranunc. acris., R. rep., R. bulb., Stell. Holost., Tilia ulmif., Rubus frutic., R. Id., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Sorbus Auc., Saxifr. granul., Myrrhis odor., Viburn. Opul., Asperula odor., Knaut. arv., Chrysanth. Leucanth., Carduus deflorat., Convolv. sep., Veron. Cham., Mentha aquat., Polygon. vivip.
549. E. trigramma *Mg.*—Ranunc. lanug., Sorbus scand., Valerian. olitor.
550. E. truncata *Mg.*—Veron. off.
551. E. vernalis *Mg.*—Stenophrag. Thalian., Myrrhis odor., Myosot. sylv., Hotton. pal. F+I+.
552. E. sp.—Ranunc. Fic., Sinap. arv., Teesdal. nudicaul., Geran. Robert., Melilot. altiss. F+I+, M. off. F+I+, Crat. Oxyac., Sium latif., Knaut. arv., Inula hirta, Centaur. Scab., Convolv. sep., Calamintha alpina, Rheum undul., Salix cin., S. Capr., S. aurit.
553. Hilara chorica *Fall.* (?)—Armer. vulg.
554. H. maura *F.*—Batrach. aquat., Euphorb. palustr.
555. H. quadrivittata *Mg.*—Ranunc. acris, R. rep., R. bulb., Spergular. sal., Stell. gramin., Cerast. triv., Potent. Anser., Carum Carvi, Anthrisc. sylv., Galium Mollugo, G. palustre, Bellis per., Tarax. off., Hierac. Pilos., Armer. elong.
556. H. sp.—Valerian. olitor.
557. Miccophorus velutinus *Macq.*—Crat. Oxyac.
558. M. sp.—Myosur. minim.
559. Pachymeria palparis *Egg.*—Succ. prat.
560. Platypalpus candicans *Fall.*—Myrrhis odor.
561. P. flavipalpis *Mg.*—Anthrisc sylv.
562. Rhamphomyia anthracina *Mg.*—Polygon. Bist.
563. R. plumipes *Fall.*—Camp. rot.
564. R. sulcata *Fall.*—Salix cin., S. Capr., S. aurit.
565. R. tenuirostris *Fall.*—Pimpin. Saxifr.
566. R. umbripennis *Mg.*—Ranunc. acris, R. rep., R. bulb., Heracl. Sphond., Myrrhis odor.

567. R. sp.—Anem. sylv., Asperula cynanch., Succ. prat., Mentha aquat., Armer. elong., Antheric. Lil.
568. Tachydromia connexa *Mg.*—Anem. sylv., Crat. Oxyac.
569. T. sp.—Hyper. perfor., Calla pal. F+I+.

K. Leptidae.

570. Atherix ibis *F.*—Oenanthe fistul.
571. Leptis strigosa *Mg.*—Cerast. arv.
572. L. tringaria *L.*—Senec. nemor.
573. L. sp.—Potent. sylv.
574. Ptiolina crassicornis *Pz.*—Medic. lupul.

L. Lonchopteridae.

575. Lonchoptera punctum *Mg.*—Valerian. olit.
576. L. sp.—Chrysospl. oppositif., Mentha aquat.

M. Muscidae.

577. Genus et sp. ?—Wahlenbergia hederac.
578. Actora aestuum *Mg.*—Tussil. Farf., Salix Capr., S. vimin., S. purp.
579. Agromyza flaveola *Fall.*—Toril. Anthrisc.
580. Alophora hemiptera *F.*—Pastin. sat., Daucus Car.
581. Anthomyia aestiva *Mg.*—Cerast. arv.
582. A. albecens *Zett.*—Eryng. campest.
583. A. aterrima *Mg.*—Myrrhis odor.
584. A. brevicornis *Zett.*—Parnass. pal., Daucus Car., Succ. prat., Eupator. cannab., Pulicar. dysenter., Mentha aquat.
585. Anthomyia lucidiventris *Zett.*—Salix rep.
586. A. muscaria (*Zett.*) *Mg.*—Anthrisc. sylv., Veron. Cham., Salix rep.
587. A. obelisca *Mg.*—Ruta graveol.
588. A. pluvialis *L.*—Crat. Oxyac., Apocyn. androsaemifol. F−I−.
589. A. pratensis *Mg.*—Ranunc. acris, R. rep., R. bulb., Ruta graveol., Limnanth. nymph.
590. A. radicum *L.*—Ranunc. auric., R. Fic., Helianth. vulg., Hyper. perfor., Erod. Cicut. var. pimpinellif., Ruta graveol., Potent. sylv., Ulmar. pentap., Pyrus comm., Parnassia pal., Pimpin. Saxifr., Angel. sylv., Daucus Car., Toril. Anthrisc., Anthrisc. Cerefol., Succisa pratens., Eupator. cannab., Aster. Tripol., Pulicar. dysenter., Achill. Millef., Matric. inod., Senec. Jacob., Centaur. nigr., Leont. aut., Camp. rot., Jas. mont., Call. vulg., Myosot. sylv., Mentha aquat., Stachys pal., Narth. ossifr.
591. A. triquetra *Wiedem.*—Carum Carvi.
592. A. sp.—Anem. nem., Adon. vern., Myosur. minim., Batrach. aquat., Ranunc. Flamm., R. acris, R. rep., R. bulb., R. lanugin., R. scelerat., R. Fic., Caltha pal., Barbar. vulg., Arab. aren., Cardam. prat., Sisymbr. off., S. Soph., Alliar. off., Brass. nig., Alyss. mont., Eroph. verna., Thlaspi arv., Caps. Bursa-past., Viola lutea, Gypsoph. panic., Spergular. sal., Holost. umbell., Stellar. gram., S. Holost., S. med., Malach. aquat., Cerast. triv., Hyper. perfor., Geran. pal., G. pyren., G. alban., G. sibir., Erod. cicut., Med. lupul., Prunus spin., Rosa can., Rubus caes., Waldsteinia geoid., W. fragaroid., Fragaria vesca, Potent. Anser., P. arg., P. aurea, P. frutic., Agrimon. Eupat., Ulmar. pentap., Spir. sorbif., S. salicif., S. ulmif., Arunc. sylv., Epil. mont., Circaea lutet. F+I+, Scleranth. per., Sedum acre, S. refl., Astrant. helleborif., Eryng. camp., Conium macul., Conioselin. tartaric., Levistic. off., Angel. sylv., Peucedan. ruthen., Aneth. graveol., Aegop. Podagr., Bupleur. rotundif., Carum Carvi, Pastin. sat., Orlaya grandifl., Anthrisc. Cerefol., Myrrhis odor., Galium Mollugo, G. tricorne, Valer. off., Succ. prat., Eupator. ageratoid., Tussil. Farf., Aster. Tripol., A. Amell., A. salicif., A. abbrev., A. concinn., A. florib., A. Novae-Belg., A. panicul., A. sagittif., A. sparsifl., Biotia commixta, Chrysoc. Linosyr., Bellis per., Diplopapp. amygdal., Solidago canad., S. ambigua, S. caes., S. glabra, S. latif., S. lithospermif., S. livida, S. Ohicens., S. Ridellii, S. rigida, S. ulmif., Bolton. glastif., Achill. millef., A. grandifl., Anthem. tinct., A. rigesc., Matric. inod., Tanac. alp., Chrysanth. Leucanth., Doron. Pardalianch., Senec. vulg., S. nebrod., Cirs. arv., Carlina vulg., Centaur. Cyan., Leont. aut., Tragop. flocc., Hypoch. rad., Sonchus asp., Hierac. Pilos., H. brevif., Camp. rot., Jas. mont., Call. vulg., Pyrola min., Apocyn. androsaemifol. F−I−, Limnanth. nymph., Gent.

Pneum., Convolv. sep., Echinosperm. Lapp., Myosot. collina. Verbasc. Lychnit., Veron. Cham., V. mont., V. Anagall., V. agrest., Origan. vulg., Hotton. pal. F+I+, Glaux marit., Chenopod. alb., Rheum undul., Polygon. Bistorta, P. cuspid., Euphorb. heliosc., E. cypariss., E. palustr., E. Esula., E. aspersa, E. nicaeens., Salix rep., Butom. umbell., Cyprip. Calc. F±I±, Tulipa sylv., Antheric. ramos.

593. Aricia albolineata *Fall.*—Cak. marit.
594. A. basalis *Zett.*—Ranunc. acris, R. rep., R. bulb., Knaut. arv., Chrysanth. Leucanth., Cirs. arv., Leont. aut.
595. *A. denudata Holmgr.* (=Spilogaster denudata *Holmgr.*).—Cerast. alp.
596. A. dispar *Mg.*—Ranunc. scelerat., Salix rep.
597. *Aricia dorsata Zett.* (=Spilogaster dorsata *Zett.*).—Cerast. alp., Dryas octopet.
598. A. incana *Wiedem.* (cf. No. 703).—Ranunc acris, R. rep., R. bulb., R. Ling., R. scelerat., Barbar. vulg., Spergular. Sal., Cerast. triv., Hyper. tetrapt., Geum urb., Comarum pal., Potent. Anser., Scleranth. per., Carum Carvi, Sium latif., Angel. sylv., Anthrisc. sylv., Galium Mollugo, Valerian. olitor., Knaut. arv., Achill. Millef., Senec. Jacob., Cirs. arv., Leont. aut., Jas. mont., Gent. Pneum., Myosot. intermed., Hotton. pal. F+I+, Glaux marit., Polygon. amphib.
599. A. lardaria *F.*—Comar. pal., Hedera Helix, Armer. elong.
600. A. lucorum *Fall.*—Angel. sylv., Hedera Helix, Salix rep.
601. *A. megastoma Bohem.* (=Chortophila megastoma *Bohem.*).—Cerast. alp., Dryas octopet., Saxifr. caespit.
602. A. obscurata *Mg.*—Aegop. Podagr., Carum Carvi, Aster Tripol.
603. A. serva *Mg.*—Caltha pal., Crat. Oxyac., Pimpin. Saxifr., Leont. aut.
604. A. vagans *Fall.*—Hyper. quadrang., H. tetrapt., Rosa can., Conium macul., Oenanthe aquat., Achill. Millef., A. Ptarm., Armer. elong.
605. A. sp.—Rubus frutic., Potent. Anser., P. arg., Parnass. pal., Sium latif., Peucedan. pal., Valer. off., Inula hirta, Anthem. tinct., Tanacet. corymbos., Senec. nemor.
606. Besseria melanura *Mg.*—Achill. Millef.
607. Borborus equinus *Fall.* (cf. No. 642).—Salix rep., Arum pict., Dracunc. vulg.
608. B. niger *Mg.*—Adoxa Moschat.
609. B. sp.—Crambe marit. F±I±.
610. Calliphora erythrocephala *Mg.*—Ranunc. rep., R. Ling., Asimina tril., Brass. nig., Hyper. perfor., Ruta graveol., Euon. europ., E. latif., Rhus Cotinus, Potent. Anser., Pyrus comm., Sedum acre, Ribes Grossul., Parnass. pal., Heracl. Sphond., Daucus Car., Anthrisc. sylv., Hedera Helix, Valer. off., Succ. pratens., Eupator. cannabin., Aster Novae-Angliae, Solidago canadens., S. bicolor, S. laterifl., Pulicar. dysenter., Achill. Millef., Senec. Jacob., Calend. off., Cirs. arv., Onopord. Acanth., Serrat. tinct., Tragopog. prat., Tarax. off., Call. vulg., Linar. vulg., Veron. serpyllif., Mentha aquat., Polygon. cuspid., Salix cin., S. Capr., S. aurit., S. rep., Fritill. Kamtschatc., Ammophila aren.
611. C. vomitoria *L.*—Anem. sylv., Nuph. lut., Brass. nig., Sinap. arv., Cak. marit., Hyper. perfor., Erod. cicut., Euon. europ., Celastr. Orixa, Prunus Padus, Pyrus Malus, Ribes Gross., Saxifr. granul., Conium macul., Smyrn. Olusatr., Sium latif., Heracl. Sphond., Daucus Car., Aucuba japon., Aster salicif., A. sagittif., Solidago frag., Helianth. scabra, Cirs. arv., Stapelia grandifl., Heliotrop. peruv., Polygon. cuspid., Buxus semperv., Dracunc. vulg., Tamus comm., Veratr. nigr.
612. C. sp.—Archangel. off., Helicodic. muscivor., Ammophila aren.
613. Calobata cothurnata *Pz.*—Ranunc. acris, R. rep., R. bulb., Nasturt. amphib., Barbar. vulg., Myrrhis odor., Myosot. sylvat.
614. *Caricea tigrina F.* (=Coenosia tigrina *F.*, cf. No. 640).—Medic. sat. F±I±, M. sylv., M. lupul., Angelic. sylv.
615. Cephalia nigripes *Mg.*—Viola can.
616. Chloria demandata *F.*—Aegopod. alpestre, Conioselin. tatar., Peucedan. Ruthen., Myrrhis odor., Chrysoc. Linosyr., Diplopapp. amygd., Solidago glabra, Echinops exaltat.
617. *Chloropisca ornata Mg.* (=Chlorops ornata *Mg.*).—Hedera Helix.
618. Chlorops circumdata *Mg.*—Stell. med.
619. C. hypostigma *Mg.*—Anem. sylv., Myrrhis odor.
620. C. scalaris *Mg.*—Myosot. sylv.
621. C. sp.—Medic. lupul., Prunus spin., Anthrisc. sylv., Sherard. arv.

622. Chortophila cilicrura *Rond.* (=Phorbia).—Erod. cicut. var. pimpinellif.
623. C. cinerella *Fall.*—Medic. lupul., Salix rep.
624. C. dissecta *Mg.* (=Phorbia).—Erod. cicut. var. pimpinellif.
625. C. floccosa *Mg.* (=Phorbia, cf. No. 799).—Erod. cicut. var. pimpinellif.
626. C. latipennis *Zett.*—Salix rep.
627. C. sepitorum *Meade* (=Phorbia).—Medic. lupul.
628. C. sp.—Medic. lupul.
629. Cistogaster globosa *F.*—Achill. Millef.
630. Clairvillia ocypterina *R.-D.*—Daucus Car.
631. Cleigastra flavipes *Fall*—Salix rep.
632. C. sp.—Nuphar lut., Vicia sat.
633. Clytia pellucens *Fall.*—Siler trilob.
634. Cnephalia bucephala *Mg.*—Eryng. camp.
635. Coelopa frigida *Fall.*—Ranunc. acris, R. rep., R. bulb., Brass. nig., Cochlear. off., Coronop. Ruellii, Aegopod. Podagr., Heracl. Sphond., Galium verum, Bellis per., Matricar. inod., Cirs. arv., C. lanceolat., Leont. aut., Tarax. off., Convolv. arv., Solan. tuberos., Euphorb. heliosc., E. Pepl., Epipact. pal. F+I+, Ammophila aren.
636. C. pilipes *Hal.*—Heracl. Sphond.
637. C. sp.—Potent. steril., Parnass. pal., Tussil. Farf., Pulicar. dysenter., Mentha aquat.
638. Coenosia decipiens *Mg.*—Salix. rep.
639. C. intermedia *Fall.*—Myrrhis odor.
640. C. tigrina *F.* (cf. No. 614).—Galium Mollugo, G. verum, G. verum × G. Moll., Polygon. amphib.
641. C. sp.—Hypoch. rad., Sherard. arv.
642. *Copromyza equina Fall.* (=Borborus equinus *Fall.*, cf. No. 607).—Arum pict.
643. Cordylura pubera *L.*—Myrrhis odor.
644. Cynomyia mortuorum *L.*—Brass. nig., Caps. Bursa-past., Crat. Oxyac., Scleranth. perenn., Sedum acre, Ribes aureum, Parnass. pal., Peucedan. Oreoselin., Heracl. Sphond., Anthrisc. sylv., Galium Moll., Valer. exaltata, Achill. Millef., Cirs. arv., Card. crisp., Tarax. off., Sonchus arv., Hierac. umbellat., Linar. vulg., Glaux marit., Armer elong., Salix rep., Narth. ossif.
645. Cyrtoneura assimilis *Fall.*—Asimina triloba.
646. C. caerulescens *Macq.*—Ranunc. acris, R. rep., R. bulb.
647. C. curvipes *Macq.*—Potent. sylv., Ulmar. pentapet., Conium macul., Oenanthe aquat., Angel. sylv., Aneth. graveol., Euphorb. palustr.
648. C. hortorum *Fall.*—Batrach. aquat., Potent. Anser., Crat. Oxyac., Carum Carvi, Angel. sylv., Anthrisc. sylv., Tarax. off., Hierac. Pilos., Euphorb. palustr.
649. C. pascuorum *Mg.*—Asimina triloba.
650. C. podagrica *Loew.*—Polygon. Bist.
651. C. simplex *Loew.*—Spir. sorbif., S. salicif., S. ulmif., Petrosel. sat., Sium latif., Anthrisc. Ceref., Achill. Millef., Polygon. Bist.
652. C. stabulans *Fall.*—Asimina triloba.
653. C. sp.—Crat. Oxyac.
654. Demoticus plebeius *Fall.*—Hypoch. rad.
655. Dexia canina *F.*—Knaut. arv., Eupator. cannabin.
656. D. rustica *F.*—Rubus frutic., Pastin. sat.
657. Drosophila funebris *F.*—Arum ital. F+I+.
658. D. graminum *Fall.*—Cochlear. off., Daucus Car., Hedera Helix, Matricar. inod., Salix purp., Calla pal. F+I+.
659. Drymeia hamata *Fall.*—Rubus caes., Pulicar. dysenter.
660. Dryomyza anilis *Fall.*—Anthrisc. sylv.
661. D. flaveola *F.*—Myrrhis odor.
662. Echinomyia fera *L.*—Geran. pyren., Euon. europ., Spir. sorbif., S. salicif., S. ulmif, Crat. Oxyac., Sorb. Auc., Sedum album, Eryng. camp., Aegopod. Podagr., Carum Carvi, Angel. sylv., Heracl. Sphond., Anthrisc. sylv., Moloposperm. Peloponnes., Viburn. Opul., Valer. off., V. alliariif., Succ. austral., Scab. suaveol., Eupator. cannabin., E. ageratoides, Aster Amell., A. abbreviat., A. concinn., A. laevis, A. Lindleyan., A. paniculat., A. sparsifl., A. squarrul., Biotia commixta, B. corymb., B. macrophylla, B. Schreberi, Chrysoc. Linosyr., Diplopapp. amygd., Solidago canad., S. ambigua, S. fragr., S. glabra, S. laterifl., Coreops auricul., C. lanceol., Achill. Ptarm., A. Millef.,

Senec. nemor., S. macrophyll., Cirs. pal., Phlox panicul., Plectranth. glaucocalyx, Mentha piperita, Origan. vulg., Thym. Serp.
663. E. ferina *Zett.*—Thym. Serp.
664. E. ferox *Pz.*—Siler trilob., Jas. mont., Erica Tetr., Thym. Serp.
665. E. grossa *L.*—Rubus frutic., Sedum album, Aegopod. Podagr., Heracl. Sphond., Lact. mural., Call. vulg., Thym. Serp.
666. E. lurida *F.*—Heracl. Sphond.
667. E. magnicornis *Zett.*—Spir. sorbif., S. salicif., S. ulmif., Sedum Teleph., Heracl. Sphond., Senec. sylv., Mentha sylv.
668. E. tessellata *F.*—Knaut. arv., Anthem. arv., Chrysanth. Leucanth., Senec. nemor., Hierac. Pilos., H. umbellat., Achill. Millef., A. Ptarm., Jas. mont., Call. vulg., Mentha sylv., Thym. Serp., Stachys pal.
669. E. sp.—Adenost. alb., Myosot. sylv.
670. Ensina sonchi *L.*—Mentha aquat.
671. Ephydra sp.—Tussil. Farf.
672. Exorista fimbriata *Mg.*—Salix rep.
673. E. lucorum *Mg.*—Peucedan. Oreoselin.
674. E. vulgaris *Fall.*—Heracl. Sphond., Anthrisc. Cerefol.
675. E. sp.—Salix cin., S. Capr., S. aurit.
676. Frontina laeta *Mg.*—Angel. sylv., Pastin. sat., Heracl. Sphond.
677. Fucellia fucorum *Fall.*—Ranunc. acris, R. rep., R. bulb., Brass. nig., Coronop. Ruellii, Honcken. peploid., Aegopod. Podagr., Matric. inod., Euphorb. heliosc., Ammophila aren.
678. Germaria ruficeps *F.*—Daucus Car., Pastin. sat.
679. Gonia capitata *Deg.*—Trif. arv., Crep. bienn., Achill. Millef., A. Ptarm., Thym, Serp., Salix cin., S. Capr., S. aurit., Allium rot.
680. G. fasciata *Mg.*—Salix rep.
681. G. ornata *Mg.*—Salix cin., S. Capr., S. aurit., S. rep.
682. Graphomyia maculata *Scop.*—Crat. Oxyac., Astrant. major, Aegopod. Podagr., Sium latif., Angel. sylv., Peucedan. Cervar., Heracl. Sphond., Anthrisc. sylv., Chaerophyll. aur., C. hirsut., Prangos ferulac., Diplopapp. amygd., Coreops auricul., Polygon. cuspid., Euphorb. palustr.
683. *Gymnopa opaca Rond.* (=Mosillus opacus *Rond.*)—Ceropeia elegans F+I+.
684. Gymnosoma nitens *Mg.*—Achill. Millef.
685. G. rotundata *L.*—Spir. sorbif., S. salicif., S. ulmif., Carum Carvi, Bupleur. falcat., B. rotundif., Peucedan. Cervar., Aneth. graveol., Heracl. Sphond., Daucus Car., Orlaya grandifl., Toril. Anthrisc., Anthrisc. Ceref., Chaerophyll. temul., Achill. Millef., A. Ptarm., Anthem. tinct., Tanacet. vulg., Senec. Jacob., Thym. Serp.
686. Helomyza affinis *Mg.*—Neott. Nid.-av. F+I+.
687. H. sp.—Cerast. triv., Tussil. Farf., Bellis per., Tarax. off., Salix vimin.
688. Herina frondescentiae *L.*—Cirs. pal.
689. Homalomyia armata *Mg.*—Medic. lupul.
690. H. canicularis *L.*—Origan. vulg.
691. H. pretiosa *Schin.*—Heracl. Sphond.
692. *H. prostrata Rossi* (=H. incisurata *Zett.*).—Asimina triloba.
693. H. scalaris *F.*—Ranunc. acris, R. rep., R. bulb., Knaut. arv., Bellis per.
694. H. sp.—Salix rep.
695. Hydrellia chrysostoma *Mg.*—Myosur. minim.
696. H. griseola *Fall.*—Myosur. minim., Batrach. aquat., Medic. lupul., Potent. sylv., Parnass. pal., Daucus Car., Hedera Helix, Achill. Millef., Matric. inod., Leont. aut., Calla pal. F+I+, Narth. ossifr.
697. H. sp.—Salix rep.
698. Hydrotaea bispinosa *Zett.*—Salix rep.
699. H. ciliata *F.*—Ranunc. acris, Crat. Oxyac.
700. H. dentipes *F.*—Caltha pal., Stell. Holost., Heracl. Sphond.
701. H. irritans *Fall.*—Medic. lupul.
702. H. sp.—Galium Mollugo, Chrysanth. Leucanth.
703. *Hyetodesia incana Wiedem.* (=Aricia incana *Wiedem.*, cf. No. 598).—Pimpin. Saxifr., Succ. prat., Aster Tripol., Achill. Millef., Senec. Jacob.
704. Hylemyia cinerella *Mg.*—Eroph. verna.
705. H. cinerosa *Zett.*—Salix rep.
706. H. conica *Wied.*—Ranunc. lanugin., Carum Carvi, Anthrisc. sylv.
707. H. lasciva *Zett.*—Viola lutea, Potent. sylv., Succ. prat., Narth. ossifr.

708. H. pullula *Zett.*—Medic. lupul., Salix rep.
709. H. strigosa *F.*—Toril. Anthrisc., Succ. prat., Pulicar. dysenter., Centaur. nigra,
710. H. variata *Fall.*—Galium Mollugo, G. verum., G. verum × G. Moll.
711. H. sp.—Batrach. aquat., Cochlear. off., Ulex europ. F±I±, Galium Mollugo, G. verum, G. verum × G. Moll., Tussil. Farf., Salix vimin., S. purp.
712. Lasiops apicalis *Mg.*—Aegopod. Podagr.
713. L. cunctans *Mg.* (cf. No. 883).—Pimpin. Saxifr.
714. L. sp.—Tussil. Farf.
715. Lauxania aenea *Fall.*—Symphoricarp. racem. F+I+.
716. L. cylindricornis *F.*—Achill. Millef.
717. Leucostoma aenescens *Zett.*—Achill. Millef.
718. L. analis *Mg.*—Heracl. Sphond.
719. Limnophora littorea *Fall.*—Salix rep.
720. L. protuberans *Zett.*—Tarax. off.
721. L. quadrimaculata *Fall.*—Carum Carvi.
722. L. septemnotata *Zett.*—Salix purp.
723. L. sp.—Hedera Helix, Call. vulg., Myosot. intermed.
724. Limosina crassimana *Hal.*—Arum ital. F+I+.
725. L. pygmaea *Zett.*—Arum ital. F+I+.
726. L. simplicimana *Rond.*—Dracunc. vulg. F+I+.
727. Lonchaea tarsata Fall.—Aristol. Sipho F+I+.
728. Lophosia fasciata *Mg.*—Rhamn. Frang.
729. Loxocera elongata *Mg.*—Polygon. Bist.
730. Lucilia albiceps *Mg.*—Eupator. cannabin., Mentha arv.
731. Lucilia caesar *L.*—Ranunc. acris, R. rep., R. bulb., R. Ling., R. auric., R. scelerat., Brass. nig., Sapon. off., Spergular. sal., Honcken. peploid., Stell. med., Cerast. triv., Ampelops. quinquef., Geran. pal., G. molle, Erod. cicut. var. pimpinellif., Ruta graveol., Staphyl. pinn., Prunus Padus, Rubus caes., R. Id., Comarum pal., Potent. Anser., Crat. Oxyac., Pyrus Malus, Sorb. Auc., Sicyos angul., Sedum acre, Saxifr. decip., S. umbr., Parnass. pal., Astrant. major, Eryng. camp., E. planum, Conium macul., Cicuta vir., Petrosel. sat., Aegopod. Podagr., Carum Carvi, Pimpin. Saxifr., Sium latif., Angel. sylv., Imperat. Ostruth., Aneth. graveol., Heracl. Sphond., Daucus Car., Anthrisc. sylv., Myrrhis odor., Prangos ferulac., Cornus sang., Ebul. humile, Sambuc. nigra, Galium Mollugo, G. verum, Valerianella olitor., Tussil. Farf., Aster Tripol., A. salicif., A. azur., A. laevis, A. sagittif., Biotia commixta, Galatella hyssopif., Bellis per., Solidago Virgaurea, S. canad., S. bicolor, S. glabra, S. laterifl., S. livida, Achill. Millef., Anthem. arv., A. tinct., Matric. inod., Tanacet. vulg., T. macrophyll., Chrysanth. seget., Chrys. Leucanth., Doronic. Pardalianch., D. austriac., Senec. Jacob., Cirs. arv., C. lanceolat., Leont. aut., Tarax. off., Hierac. umbellat., Convolv. arv., Solanum tuberos., Plectranth. glaucocalyx, Elssholzia crist., Mentha piperita, M. aquatica, M. sylv., Glaux marit., Armer. elong., Polygon. cuspid., Asarum europ. ↑, Euphorb. heliosc., E. verrucosa, E. Gerard., E. Pepl., E. pilosa, E. aspera, E. virgata, Salix rep., Arum crinit., Narth. ossifr., Veratr. nigr., Ammophila aren.
732. L. cornicina *F.*—Ranunc. Fic., Alyss. mont., Stell. med., Tilia ulmif., Erod. cicut., Ruta graveol., Euon. europ., Rhus Cotinus, Ulex europ. F±I±, Potent. sylv., P. frutic., P. steril., Spir. sorbif., S. salicif., S. ulmif., Cydonia jap., Pyrus comm., Circaea lutet., Astrant. major, Conium macul., Petroselin. sat., Aegopod. Podagr., Sium latif., Oenanthe aquat., Aneth. graveol., Heracl. Sphond., Daucus Car., Cornus sanguinea, Valeriana offic., Succisa pratens., Eupator. cannabin., Tussil. Farf., Petasit. frag., Aster Tripol., A. Novae-Angliae, A. salicif., Bellis per., Solidago canad., Pulicar. dysenter., Bidens cern., Anthem. tinct., Matric. Chamom., M. inod., Chrysanth. seget., C. Leucanth., Senec. aquat., Echinops sphaerocephal., Cirs. arv., Scorzon. humil., Tarax. off., Jas. mont., Call. vulg., Convolv. sep., Veron. Tournefortii, Mentha arv., M. aquat., Lycopus europ., Thym. Serp., Lam. purp. F±I+, ? F+I+, Polygon. Fagopyr., P. cuspid., Salix. Capr.
733. L. latifrons *Schin.*—Achill. Millef., Cirs. arv., Jas. mont., Call. vulg., Linar. vulg.
734. L. sericata *Mg.*—Asimina triloba, Medic. sat. F±I±, M. sylvestr., Angel. sylv., Heracl. Sphond., Anthrisc. sylv., Achill. Millef., Senec. Jacob., Cirs. arv., Salix. rep.
735. L. sylvarum *Mg.*—Gypsoph. panic., Erod. cicut. var. pimpinellif., Ruta

graveol., Potent. frutic., Spir. sorbif., S. salicif., S. ulmif., Aegopod. Podagr., Sium latif., Angel. sylv., Pastin. sat., Heracl. Sphond., Daucus Car., Boltonia glastif., Chrysanth. Leucanth., Mentha arv., Lycopus europ.

736. L. splendida *Mg.*—Daucus Car.
737. L. sp. (cf. No. 850).—Nasturt. off., Arab. aren., Sinap. arv., Sperg. arv., Rubus frutic., R. caes., Sedum acre, Carum Carvi, Oenanthe fistul., Archangel. off., Daucus Car., Hedera Helix, Valerian. olit., Succ. prat., Gnaph. lut.-alb., Senec. Jacob., Asclep. syr. F+I+, Thym. Serp., Polygon. amphib., Dracunc. vulg. F+I+, Orchis mac. F+I+.
738. Macquartia chalybeata *Mg.*—Aegopod. Podagr.
739. M. nitida *Zett.*—Aegopod. Podagr.
740. M. praefica *Mg.*—Chrysanth. Leucanth.
741. *Megaglossa umbrarum Mg.* (=Platystoma umbrarum *F.*).—Asimina triloba.
742. Meigenia floralis *Mg.*—Pimpin. Saxifr.
743. Melania bifasciata *Mg.*—Eryng. camp.
744. M. volvulus *F.*—Eryng. camp.
745. Mesembrina meridiana *L.*—Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Sium latif., Angel. sylv., Heracl. Sphond.
746. M. mystacea *L.*—Heracl. Sphond.
747. Metopia argentata *Macq.*—Achill. Millef.
748. M. leucocephala *Rossi.*—Heracl. Sphond.
749. Micropalpus fulgens *Mg.*—Knaut. arv.
750. Micropeza sp.—Tarax. off.
751. Miltogramma germari *Mg.*—Anthrisc. sylv.
752. M. intricata *Mg.*—Scleranth. per.
753. M. punctata *Mg.*—Astrant. major.
754. M. ruficornis *Mg.*—Daucus Car., Achill. Millef.
755. M. sp.—Gypsoph. panic., Erod. cicut., Sedum acre, Galium Mollugo.
756. Morellia curvipes *Macq.*—Pimpin. Saxifr.
757. M. importuna *Hal.*—Mentha aquat.
758. M. sp.—Hyper. perfor., Daucus Car., Pulicar. dysent., Senec. Jacob.
759. Mosillus arcuatus *Latr.*—Gypsoph. panic.
760. Musca corvina *F.*—Ranunc. scelerat., Berb. vulg., Stell. med., Fragaria vesca, Spir. sorbif., S. salicif., S. ulmif., Pyrus comm., Conium macul., Aegopod. Podagr., Sium latifol., Aneth. graveol., Heracl. Sphond., Anthrisc. sylv., Galium Mollugo, Aster Tripol., Bell. per., Solidago canadens., Achill. Millef., Chrysanth. Leucanth., Cirs. arv., Serrat. tinct., Myosot. sylv., Mentha aquat., Polygon. cuspid., Buxus semperv., Veratr. alb.
761. M. domestica *L.*—Eranth. hiem. (F+I+), Clemat. Vitalba, Anem. japon., Berb. vulg., Eroph. verna, Cak. marit., Stell. med., Tilia ulmif., Aesc. Hippocast. F±I+, Euon. europ., Celastr. Orixa, Prunus spin., Pyrus Malus, P. comm., Sorbus Auc., Lopezia coron. F+I+, Circaea lutet. F+I+, Conium macul., Petrosel. sativ., Oenanthe aquat., Crithmum marit., Heracl. Sphond., Anthrisc. sylv., Valer. off., Tussil. Farf., Bell. per., Solid. Virgaur., S. canad., Pyrola rotundif., Vincetox. purpurasc., Digital. purp., Amaranth. retrofl., Polygon. Fagopyr., P. cuspid., Buxus Semperv., Veratr. nigr.
762. M. sp.—Hyper. perfor., Rubus caes., Archang. off., Galium verum, Hierac. vulg.
763. Mydaea sp.—Hyper. perfor., Ulmar. pentap., Angel. sylv., Succ. prat., Senec. Jacob., Mentha aquat.
764. Myobia inanis *Fall.*—Medic. lupul., Angel. sylv.
765. Myodina vibrans *L.*—Aristol. Sipho. F+I+.
766. Myopites inulae *v. Roser.*—Inula ensifol.
767. Myospila meditabunda *F.*—Ranunc. sceler., Potent. Anser., Carum Carvi, Anthrisc. sylv., Tarax. off.
768. Nemopoda cylindrica *F.*—Myrrhis odor.
769. N. stercoraria *R.-D.*—Stell. med., Myrrhis odor.
770. N. sp.—Anthrisc. sylv.
771. Nemoraea consobrina *Mg.*—Comar. pal., Jas. mont.
772. N. erythrura *Mg.*—Aegopod. Podagr., Pastin. sat.
773. N. intermedia *Zett.*—Salix rep.
774. N. pellucida *Mg.*—Aegopod. Podagr., Cirs. arv.
775. N. radicum *F.*—Pimpin. Saxifr., Angel. sylv., Pastin. sat., Cirs. arv., Lycium vulg.

776. N. rudis *Fall.*—Thym. Serp.
777. N. strenua *Mg.*—Cirs. arv.
778. N. sp.—Heracl. Sphond.
779. Notiphila cinerea *Fall.*—Nymph. alba *L.*
780. N. nigricornis *Stenh.*—Nymph. alba, Nuph. lut.
781. Ocyptera brassicaria *F.*—Viola tric. alp., Trif. procumb. F+I+, Eryng. camp., Sium latif., Peucedan. Oreoselin., Orlaya grandifl., Achill. Millef., Anthem. tinct., Tanacet. parthenif., Cirs. arv., Hypoch. rad., Jas. mont., Asclep. syr., Origan. vulg., Thym. Serp.
782. O. cylindrica *F.*—Nasturt. off., Viola tric. versic. F±I+, Knaut. arv., Chrysoc. Linosyr., Cirs. arv., Achill. Millef., A. Ptarm., Jas. mont., Origan. vulg.,Thym. Serp., Allium rot.
783. O. pusilla *Mg.*—Trif. rep. F±I±, T. fragif. F±I±.
784. Olivieria lateralis *F.*—Melilot. alb., Peucedan. Oreosel., Heracl. Sphond., Achill. Millef., Matric. inod., Senec. Jacob., Cirs. arv., Carlina vulg., Jas. mont., Convolv. arv., Allium rot.
785. Onesia cognata *Mg.*—Ranunc. Fic., Berb. vulg., Potent. verna, P. steril., Spir. sorbif., S. ulmif., S. salicif., Tussil. Farf., Petasit. frag., Bellis per., Call. vulg., Popul. nigr.
786. O. floralis *R.-D.*—Batrach. aquat., Ranunc. acris, R. rep., R. bulb., Caltha pal., Berb. vulg., Nuph. lut., Teesdal. nudicaul., Gypsoph. panic., Potent. verna, Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Pyrus Malus, Sorb. Auc., Carum Carvi, Heracl. Sphond., Anthrisc. sylv., Chaerophyll. hirsut., Valer. off., Bellis per., Senec. Jacob., S. vern., Cirs. arv., Hypoch. rad., Tarax. off., Apocyn. androsaemifol. F−I−, Myosot. sylv., Mentha arv., M. aquat., Glaux marit., Euphorb. palustr., Butom. umbell.
787. O. sepulcralis *Mg.*—Batrach. aquat., Berb. vulg., Cak. marit., Cerast. arv., Rubus caes., Crat. Oxyac., Sicyos angul., Astrant. major, Angel. sylv., Pastin. sat., Heracl. Sphond., Hedera Helix, Valerian. olit., Eupator. cannabin., Tussil. Farf., Petasit. frag., Aster Tripol., A. Novae-Angliae, Chrysoc. Linosyr., Solidago caesia, S. fragr., Senec. Jacob., Jas. mont., Call. vulg., Myosot. sylv., Mentha arv., M. aquatica.
788. O. sp.—Achill. Millef.
789. Opomyza germinationis *L.*—Pyrola min., Myosot. sylv.
790. Orellia wiedemanni *Mg.*—Bryon. dioica.
791. Oscinis aristolochiae *Rond.*—Aristol. rotunda F+I+.
792. O. delpinii *Rond.*—Aristol. rotunda F+I+.
793. O. dubia *Macq.*—Aristol. Clemat. F+I+, A. rotunda F+I+.
794. O. frit. *L.*—Potent. sylv., Daucus Car., Matric. inod., Mentha aquat.
795. O. sp.—Myos. minim., Medic. lupul., Jas. mont.
796. Oxyphora miliaria *Schr.*—Carduus acanthoid., C. nutans.
797. Phasia analis *F.*—Conium macul., Peucedan. Cervar., Aneth. graveol., Heracl. Sphond., Senec. Jacob.
798. P. crassipennis *F.*—Peucedan. Cervar., Aneth. graveol., Heracl. Sphond., Daucus Car., Senec. Jacob., Achill. Millef., A. Ptarm.
799. Phorbia floccosa *Macq.* (cf. No. 625).—Pimpin. Saxifr., Achill. Millef., Toril. Anthrisc.
800. P. lactucae *Bouché.*—Pulicar. dysent.
801. P. muscaria *Mg.*—Stell. med., Salix Capr., Narc. Pseud.-Narc. F±I±.
802. P. sp.—Tussil. Farf., Salix Capr., S. purp.
803. Phorocera pumicata *Mg.*—Pastin sat.
804. Phytomyza geniculata *Macq.*—Senec. Jacob.
805. P. sp.—Parnass. pal., Hedera Helix.
806. Piophila casei *L.*—Myrrhis odor.
807. Platycephala planifrons *Fabr.*—Aster Tripol.
808. Platystoma seminationis *F.*—Anthrisc. sylv., Cirs. arv.
809. Plesina nigrisquama *Zett.*—Daucus Car.
810. Pogonomyia alpicola *Rond.*—Medic. lupul. ?
811. Pollenia rudis *F.*—Ranunc. Fic., Eranth. hiem. (F+I+), Thlaspi arv., Stell. med., Cerast. semidec., Ruta graveol., Pyrus comm., Astrant. major, Daucus Car., Hedera Helix, Tussil. Farf., Aster Tripol., A. Novae-Angliae, Bellis per., Helianth. ann., Gnaphal. lut.-alb., Matric. inod., Senec. Jacob., Echinops sphaeroceph., Call. vulg., Gent. Pneum., Lycopus europ., Viscum alb. F+I+, Salix cin., S. Capr., S. aurit

812. P. vespillo *F.*—Thalict. flav., Cerast. semidec., Potent. verna, Pyrus comm., Parnass. pal., Heracl. Sphond., Valerian. olitor., Tussil. Farf., Aster salicif., Bellis per., Rudbeckia laciniata, Matric. Chamom., Chrysanth. Leucanth., Tarax. off., Myosot. sylv., M. intermed., Polygon. Fagopyr., Viscum alb. F+I+, Salix cin., S. Capr., S. aurit.
813. P. sp.—Achill. Millef.
814. Prosena siberita *F.*—Clemat. recta, Trif. med., Lythr. Sal. F+I+, Knaut. arv., Origan. vulg.
815. Psila fimetaria *L.*—Anthrisc. sylv., Myrrhis odor., Valer. olit.
816. P. villosula *Mg.*—Carum Carvi, Anthrisc. sylv.
817. Pyrellia aenea *Zett.*—Cerast. arv., Sedum acre, Carum Carvi, Heracl. Sphond., Chrysanth. Leucanth.
818. P. cadaverina *L.*—Gypsoph. panic., Coniosel. tatar., Peucedan. ruthen., Aster Lindleyan., A. panicul., A. panic. var. pubesc., Biotia commixta, B. corymb., Chrysoc. Linosyr., Diplopappus amygd., Solid. canad., S. ambig., S. fragr., S. glabra, Bolton. glastif., Rudbeck. speciosa, Chrysanth. seget., Senec. nemor., S. macrophyll., Camp. Scheuchz., Mentha arv., Butom. umbell., Narth. ossifr.
819. Rivellia syngenesiae *F.*—Cirs. arv.
820. Saltella scutellaris *Fall.*—Achill. Millef.
821. Sapromyza apicalis *Löw.*—Aristol. Sipho. F+I+.
822. S. rorida *Fall.*—Moehr. trinerv., Anthrisc. sylv.
823. Sarcophaga albiceps *Mg.*—Ruta graveol., Aegopod. Podagr., Carum Carvi, Pimpin. Saxifr., Daucus Car., Senec. nemor., Convolv. sep., Lycopus europ., Thym. serp., T. vulg.
824. *S. atriceps Zett.* (=Onesia atriceps *Zett.*).—Valer. capitata.
825. S. carnaria *L.*—Clemat. Vitalba, Anem. japon., Batrach. aquat., Ranunc. Ling., Eroph. verna, Teesdal. nudicaul., Gypsoph. panic., Tilia ulmif., Ruta graveol., Euon. europ., Staphyl. pinn., Medic. sylv., Prunus spin., P. Padus, Rubus caes., R. frutic., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Pyrus comm., Sorbus Auc., Ribes Grossul., Parnass. pal., Astrant. major, Eryng. marit., E. camp., Petrosel. sat., Carum Carvi, Oenanthe aquat., Conioselin. tataric., Peucedan. ruthen., Pastin. sat., Heracl. Sphond., Valer. off., Aster abbreviat., A. Lindleyan., A. panicul., A. pan. var. pubescens, A. sagittifol., A. sparsiflor., Solid. canadens., S. fragr., S. glabra, S. livida, Achill. Millef., Matric. Chamom., Tanac. vulg., Senec. nemor., S. macrophyll., S. Jacob., Cirs. arv., Leont. aut., Tarax. off., Prenanth. purp., Camp. rot., Vacc. Myrt., Call. vulg., Ledum pal., Stapelia grandifl., Elssholzia crist., Mentha piperita, M. aquat., Thym. Serp., Armer. elong., Polygon. Fagopyr., P. Bist., P. cuspid., Euphorb. palustr., E. aspera, E. dendroid., Dracunc. vulg., Epipact. pal.
826. S. dissimilis *Mg.*—Anthrisc. Cerefol.
827. S. grisea *Mg.*—Eryng. camp.
828. S. haemorrhoa *Mg.*—Ruta graveol., Heracl. Sphond., Anthrisc. Cerefol., Matric. Chamom.
829. S. striata *F.*—Scleranth. per., Sedum acre, Galium Mollugo, Achill. Millef.
830. S. sp.—Medic. lupul., Parnass. pal., Angel. sylv., Carum Carvi, Daucus Car., Anthrisc. sylv., Galium sylv., Leont. aut., Aster Novae-Angl., Mentha aquat., M. sylv., Armer. elong., Ophrys muscif.
831. Sarcophila latifrons *Fall.*—Eryng. camp., Solidago fragr.
832. S. meigeni *Schin.*—Eryng. camp.
833. Scatella sp.—Heracl. Sphond.
834. Scatophaga littorea *Fall.*—Aster Tripol.
835. S. lutaria *F.*—Anthrisc. sylv., Myrrhis odor., Achill. Millef.
836. S. merdaria *F.*—Anem. nem., Adon. vern., Batrach. aquat., Ranunc. Flamm., R. auric., R. Fic., Caltha pal., Barbar. vulg., Sinap. arv., Cochlear. Armorac., Cak. marit., Stell. Holost., Cerast. arv., Aesc. Hippocast. F±I+, Geran. molle, Euon. europ., Prunus spin., Rubus Id., Fragaria vesca, Potent. Anser., P. frutic., Pyrus comm., Sorbus Auc., Ribes alp., Astrantia major, Aegop. Podagr., Carum Carvi, Angel. sylv., Heracl. Sphond., Anthrisc. sylv., Myrrhis odor., Galium Moll., Aster Tripol., Valeriana asarifol., Aster Novae-Angliae, Bellis per., Achill. Millef., Anthem. arv., Matric. inod., M. marit., Chrysanth. seget., Cirs. arv., Tragop. prat., Tarax. off., Moloposperm. Peloponn., Apocyn. androsaemifol. F−I+, Myosot. sylv., Polygon. amphib., Salix cin., S. Capr., S. aurit., S. vimin., S. rep., Scilla ital., Paris quadrif.

837. S. scybalaria *L.*—Saxifr. decip.
838. S. stercoraria *L.*—Clemat. Vitalba, Anem. nem., Batrach. aquat., Ranunc. Flamm., R. lanugin., R. scelerat., R. Fic., Caltha pal., Hellebor. pallid., Brass. nig., Sinap. arv., Cochlear. off., Cak. marit., Honcken. peploid., Stell. med., Cerast. arv., Aesc. Hippocast. F±I+, Geran. pyren., Ruta graveol., Euon. europ., Staphyl. pinn., Medic. lupul., Prunus spin., Potent. Anser., Crat. Oxyac., Sorbus Auc., Circaea lutet. F+I+, Sedum acre, Ribes alp., R. Grossul., Astrantia major, Conium macul., Aegopod. Podagr., Carum Carvi, Oenanthe aquat., Angel. sylv., Heracl. Sphond., Daucus Car., Anthrisc. sylv., Hedera Helix, Adoxa Moschat., Galium Mollugo, G. verum, Valerian. olit., Succ. prat., Eupator. cannabin., Tussil. Farf., Aster Tripol., A. Novae-Angliae, Bellis per., Pulicar. dysenter., Achill. Millef., A. Ptarm., Anthem. arv., A. tinct., Matric. discoid., Chrysanth. Leucanth., Senec. Jacob., Cirs. arv., C. lanceolat., Carduus crisp., Leont. aut., Tarax. off., Jas. mont., Call. vulg., Myosot. sylv., Veron. Beccab., Mentha aquat., Origan. vulg., Armer. vulg., Polygon. cuspid., Euphorb. dendroid., Salix cin., S. Capr., S. aurit., S. purp., Butom. umbell.
839. S. sp.—Stell. med., Medic. lupul. F+I+, Crat. Oxyac., C. monog., Oenoth. bien. F+I+, Smyrn. Olusatr., Apium graveol., Armer. elong., Polygon. amphib., Dracunc. vulg.
840. Sciomyza cinerella *Fall.*—Chrysospl. alternif.
841. Sepsis annulipes *Mg.*—Aster Amell. var. Bessarab.
842. S. atriceps *R.-D.*—Myosot. sylv.
843. S. cynipsea *L.*—Batrach. aquat., Medic. lupul., Potent. Anser., Sicyos angul., Scleranth. per., Parnass. pal., Heracl. Sphond., Daucus Car., Anthrisc. sylv., Galium Mollugo, G. pal., Aster salicif., Chrysanth. seget., Mentha aquat., Salix rep.
844. S. nigripes *Mg.*—Ranunc. Fic., Stell. Holost., S. med., Ulex europ. F±I±, Potent. steril., Chrysospl. oppositif., Anthrisc. sylv., Adoxa Moschat., Tussil. Farf., Bellis per., Tarax. off., Veron. Tournefortii, V. hederifol., Lam. purp. F±I+, ? F+I+, Salix Capr., S. purp.
845. S. sp.—Ranunc. Fic., Eranth. hiem. (F+I+), Sisymbr. Soph., Alliar. off., Cochlear. Armorac., Stell. med., Ruta graveol., Prunus spin., Potent. frutic., Pyrus comm., Sorbus Auc., Philad. coron., Conium maculat., Sium latif., Peucedan. pal., Aegopod. Podagr., Aneth. graveol., Daucus Car., Anthrisc. sylv., A. Cerefol., Myrrhis odor., Valerian. olit., Chrysanth. Leucanth., Convolv. arv., Euphorb. Esula.
846. Siphona cristata *F.*—Lepid. sat., Medic. lupul., Aegopod. Podagr., Sherard. arv., Aster Tripol.
847. S. flavifrons *Zett.*—Salix rep.
848. S. geniculata *Deg.*—Viola lutea, Stell. Holost., Medic. lupul., Potent. sylv., P. steril., Daucus Car., Hedera Helix, Asperula cynanch., A. odor., Valerian. olit., Succ. prat., Eupator. cannabin., Pulicar. dysenter., Call. vulg., Myosot. sylv., Mentha aquat., Origan. vulg., Hotton. pal. F+I+.
849. Siphonella palposa *Fall.*—Glaux marit.
850. *Somomyia* (=Lucilia) sp. (cf. No. 737).—Helicodic. muscivor.
851. Sphaerocera pusilla *Fall.*—Dracunc. vulg. F+I+.
852. Spilogaster carbonella *Zett.*—Sedum acre, Achill. Millef., Jas. mont., Apocyn. androsaemifol. F−I−.
853. S. angelicae *Scop.*—Tragop. orient.
854. S. communis *R.-D.*—Angel. sylv., Galium Mollugo, G. verum, G. verum × G. Moll., Achill. Millef., Matric. inod., Jas. mont.
855. S. depuncta *Fall.*—Salix rep.
856. S. duplaris *Zett.*—Galium Mollugo, G. verum.
857. S. duplicata *Mg.*—Erod. cicut. var. pimpinellif., Anthrisc. sylv., Galium Mollugo, G. verum, G. verum × G. Moll., Arnica mont., Viscum alb. F+I+, Euphorb. pilosa, Salix rep., Secale cereale, Agropyr. rep.
858. S. nigrita *Fall.*—Matric. Chamom.
859. S. quadrum *F.*—Parnass. pal.
860. S. semicinerea *Wied.*—Plantag. med., Cyprip. Calc. F±I±.
861. S. urbana *Mg.*—Solidago Ridellii.
862. S. vespertinea *Fall.*—Anthrisc. sylv.
863. S. sp.—Parnass. pal.
864. Spilographa meigenii *Loew.*—Cirs. olerac.

865. Stomoxys calcitrans *L.*—Hyper. perfor., Toril. Anthrisc., Achill. Millef., Cirs. arv., Mentha aquat.
866. S. stimulans *Mg.*—Galium Mollugo, G. verum, G. verum × G. Moll.
867. S. sp.—Tarax. off.
868. Tachina agilis *Mg.*—Heracl. Sphond.
869. T. erucarum *Rond.*—Heracl. Sphond.
870. T. larvarum *L.*—Angel. sylv.
871. Tephritis arnicae *L.*—Arnica mont.
872. T. conjuncta *Loew.*—Tarax. off.
873. T. elongatula *Loew.*—Tanacet. corymbos.
874. T. flavipennis *Loew.*—Achill. Millef.
875. T. pantherina *Fall.* (cf. No. 890).—Sium latif.
876. T. postica *Loew.*—Onopord. Acanth.
877. T. vespertinea *Loew.*—Aster Tripol.
878. T. zelleri *Loew.*—Inula Conyza.
879. Tephrochlamys rufiventris *Mg.*—Salix vimin.
880. Tetanocera elata *Fr.*—Ranunc. acris.
881. T. ferruginea *Fall.*—Sium latif.
882. Themira minor *Hal.*—Sisymbr. Soph., Pimpin. Saxifr., Matric. inod., Call. vulg.
883. T. putris *L.*—Teesdal. nudicaul.
884. *Trichophthicus cunctans Mg.* (=Lasiops cunctans *Mg.*, cf. No. 713).—Hedera Helix, Succ. prat., Senec. Jacob., Centaur. nigra, Leont. aut., Erica ciner., Mentha aquat.
885. *T. hirsutulus Zett.* (=Lasiopus hirsutulus *Zett.*).—Ulmar. pentap.
886. Thryptocera spec.—Batrach. aquat.
887. Trypeta acuticornis *Loew.*—Cirs. erioph.
888. T. cornuta *F.*—Centaur. Scab.
889. T. falcata *Scop.*—Tragopog. prat., T. major.
890. *T. pantherina Fall.* (=Tephritis pantherina *Fall.*, cf. No. 875).—Achill. Millef., A. Ptarm.
891. T. ruficauda *F.*—Cirs. arv., C. pal., Serrat. tinct.
892. T. tussilaginis *F.*—Lappa toment., Centaur. Scab.
893. T. winthemi *Mg.*—Heracl. Sphond., Cirs. pal.
894. T. sp.—Hypoch. rad., Armer. vulg.
895. Ulidia erythrophthalma *Mg.*—Papav. Rhoeas, Res. lutea, Malva sylv., Potent. arg., Bupleur. rotundifol., Orlaya grandifl., Asperula cynanch., A. tinct., Galium verum, G. boreale, Anthem. tinct., Matric. inod., Tanacet. corymbos., Achill. Millef., A. Ptarm., Convolv. arv., Melampyr. arv., Thym. Serp., Euphorb. Esula, Allium rot.
896. Urophora eriolepidis *Loew.*—Cirs. eriophor.
897. U. solstitialis *L.*—Carduus nut.
898. U. stigma *Loew.*—Achill. Millef., Cirs. pal.
899. U. stylata *F.*—Carduus nut.
900. Xysta cana *Mg.*—Daucus Car.
901. Zophomyia Temula *Scop.*—Aegopod. Podagr., Carum Carvi, Bellis per., Anthrisc. sylv.

N. Mycetophilidae.

902. Boletina sp.—Pimpin. Saxifr.
903. Bolitophila fusca *Mg.*—Hedera Helix.
904. Campylomyza lucorum *Rond.*—Aristol. Clemat. F+I+.
905. Exechia sp.—Chrysosplen. oppositif., Adoxa Moschat.
906. Glaphyroptera fasciola *Mg.*—Angel. sylv.
907. Platyura sp.—Heracl. Sphond.
908. Sceptonia nigra *Mg.*—Angel. sylv., Pimpin. Saxifr.
909. Sciara atrata *Holmgr.*—Cerast. alp.
910. S. minima *Mg.*—Aristol. rotunda F+I+.
911. S. nervosa *Mg.*—Arum ital. F+I+.
912. S. thomae *L.*—Oenanthe aquat., Angel. sylv., Aneth. graveol., Heracl. Sphond., Senec. Jacob.
913. S. sp.—Myos. minim., Vit. vinif., Chrysosplen. oppositif., Daucus Car., Hedera Helix, Adoxa Moschat., Valerian. olit., Matric. inod., Leont. aut., Mentha aquat.

O. Phoridae.

914. Phora carbonaria *Zett.*—Aristol. pall. F+I+.
915. P. nigra *Mg.*—Aristol. Sipho. F+I+.
916. P. pulicaria *Fall.*—Crambe marit. F+I+, Aristol. altiss. F+I+, A. pall. F+I+.
917. P. pumila *Mg.*—Aristol. Sipho. F+I+, A. altiss. F+I+.
918. P. sp.—Myosur. minim., Ranunc. Fic., Stell. med., Cerast. triv., Potent. Steril., Parnass. pal., Pimpin. Saxifr., Angel. sylv., Daucus Car., Tussil. Farf., Veron. Tournefortii, Mentha aquat.

P. Pipunculidae.

919. Pipunculus rufipes *Mg.*—Aegopod. Podagr.
920. P. ruralis *Mg.*—Heracl. Sphond.

Q. Psychodidae.

921. Pericoma sp.—Daucus Car., Mentha aquat.
922. Psychoda phalaenoides *L.* (=*P. nervosa Mg.*).—Arum maculatum F+I+, A. ital. F+I+.

R. Rhyphidae.

923. Rhyphus fenestralis *Scop.*—Salix vimin.
924. R. sp.—Adoxa Moschat.

S. Simuliidae.

925. Simulia sp.—Chrysosplen. alternif., Adoxa Moschat., Salix vimin.

T. Stratiomyidae.

926. Chrysomyia formosa *Scop.*—Ranunc. acris, Ruta graveol., Rubus frutic., Scleranth. per., Conium macul., Aegopod. Podagr., Carum Carvi, Bupleur. rotundif., Aneth. graveol., Chaerophyll. Temul., Plectranth. glaucocalyx., Plantag. med.
927. C. polita *L.*—Epil. angust.
928. Lasiopa sp.—Salix cin., S. Capr., S. aurit., S. vimin.
929. Nemotelus notatus *Zett.*—Parnass. pal.
930. N. pantherinus *L.*—Hesper. matron., Geran. prat., Anthrisc. sylv., Asperula cynanch., Anthem. arv., Matric. Chamom., Tanacet. corymbos., Chrysanth. Leucanth.
931. N. uliginosus *L.*—Sedum acre, Achill. Millef., Cirs. arv.
932. Odontomyia argentata *F.*—Caltha pal., Potent. verna.
933. O. hydroleon *L.*—Aegopod. Podagr., Cirs. arv., Centaur. rhen.
934. O. personata *Loew.*—Polygon. Bist.
935. O. tigrina *F.*—Ranunc. acris, R. rep., R. bulb., Sorb. Auc., Euphorb. palustr.
936. O. viridula *F.*—Comar. pal., Spir. sorbif., S. salicif., S. ulmif., Parnass. palustr., Sium latif., Oenanthe aquat., Anthrisc. sylv., Galium Mollugo, Achill. Millef., A. Ptarm., Tanacet. vulg., Chrysanth. Leucanth., Senec. Jacob., Cirs. arv., Convolv. arv., Mentha arv., Polygon. Fagopyr.
937. Oxycera pulchella *Mg.*—Rosa rubigin., Melampyr. prat. F±I±.
938. Sargus cuprarius *L.*—Malva sylv., Impat. Noli-tang. F±I±, Ruta graveol., Rubus frutic., R. caes., Potent. frutic., Conium macul., Aegopod. Podagr., Sambuc. nigra, Galium Mollugo.
939. S. flavipes *Mg.*—Melampyr. prat. F±I±.
940. S. infuscatus *Mg.*—Aegopod. Podagr.
941. Stratiomys chamaeleon *Deg.*—Aegopod. Podagr., Oenanthe fistul., Peucedan. Oreoselin., Aneth. graveol., Heracl. Sphond., Daucus Car., Anthrisc. sylv., Polygon. Fagopyr.
942. S. equestris *Mg.*—Heracl. Sphond.
943. S. furcata *F.*—Crat. Oxyac., Sium latif., Heracl. Sphond., Daucus Car.
944. S. longicornis *F.*—Carum Carvi, Peucedan. Oreoselin., Daucus Car., Chaerophyll. aureum, Molopospermum. Peloponnes.
945. S. riparia *Mg.*—Spir. sorbif., S. salicif., S. ulmif., Sium latif., Daucus Car., Polygon. Fagopyr.

U. Syrphidae.

946. Arctophila mussitans *F.*—Heracl. Sphond., Succ. prat., Senec. Jacob., Call. vulg., Mentha aquat.

947. Ascia lanceolata *Mg.*—Ranunc. lanugin., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Heracl. Sphond., Tarax. off.
948. A. podagrica *F.*—Anem. sylv., Ranunc. acris, R. rep., R. lanugin., Caltha pal., Berb. vulg., Chelidon. majus, Barbar. vulg., Sisymbr. off., Stenophragma Thalian., Teesdal. nudicaul., Lepid. sat., Caps. Bursa-past., Helianth. vulg., Gypsoph. panic., Stell. med., Malach. aquat., Hyper. perfor., Geran. pyren., G. molle, G. pusill., Erod. cicut. var. pimpinellif., Ruta graveol., Rubus frutic., R. Id., Agrim. Eupat., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Pyrus comm., Circaea lutet. F+I+, Philad. coron., Bryon. dioica, Saxifr. Aizoon, S. umbrosa, Aethusa Cynap., Heracl. Sphond., Daucus Car., Toril. Anthrisc., Anthrisc. sylv., Valerian. olit., Bellis per., Matricar. inod., Senec. Jacob., Lamps. comm., Tarax. off., Myosot. intermed., Solanum nigr., Verbasc. Thapsus, Veron. Cham., V. mont., V. Anagall., V. Beccab., Elssholzia crist., Mentha aquatica, Origan. vulg., Plantag. med., Rheum undul., Polygon. Bistorta, P. Persic., P. lapathifol., P. mite, P. avicul., Euphorbia verrucosa, E. palustr., Alisma Plant.
949. Bacha elongata *F.*—Ranunc. lanug., Circaea lutet. F+I+, Heracl. Sphond., Chaerophyll. temul.
950. Brachyopa bicolor *Fall.*—Leont. aut.
951. B. ferruginea *Fall.*—Aegopod. Podagr.
952. Brachypalpus valgus *Pz.*—Ranunc. Fic., Salix cin., S. Capr., S. aurit.
953. Ceria conopsoides *L.*—Bunias orient.
954. Cheilosia albitarsis *Mg.*—Ranunc. acris, R. rep., R. bulb., R. lanugin., Caltha pal.
955. C. antiqua *Mg.* (cf. No. 979).—Ranunc. acris, R. rep., R. bulb., R. mont., Arnica mont., Leont. hastil.
956. C. barbata *Loew.*—Daucus Car., Senec. Jacob.
957. C. brachysoma *Egg.*—Potent. aurea, Salix cin., S. Capr., S. aurit.
958. C. caerulescens *Mg.*—Aster alpin.
959. C. canicularis *Pz.*—Senec. nemor., Leont. hastil., Achyrophor. unifl., Tarax. off.
960. C. chloris *Mg.*—Tarax. off., Salix cin., S. Capr., S. aurit.
961. C. chrysocoma *Mg.*—Crep. bienn., C. vir., C. tector.
962. C. decidua *Egg.*—Anthrisc. sylv. (?)
963. C. flavicornis *F.*—Salix sp.
964. C. fraterna *Mg.*—Chrysanth. Leucanth.
965. C. gilvipes *Zett.*—Spir. sorbif., S. salicif., S. ulmif.
966. C. impressa *Loew.*—Daucus Car.
967. C. longula *Zett.*—Call. vulg.
968. C. modesta *Egg.*—Potent. verna, Saxifr. Aizoon, Salix cin., S. Capr., S. aurit.
969. C. mutabilis *Fall.*—Heracl. Sphond.
970. C. nebulosa *Verral.*—Ranunc. Fic.
971. C. oestracea *L.*—Pimpin. Saxifr., Angel. sylv., Heracl. Sphond., Cirs. arv.
972. C. personata *Loew.*—Knaut. sylv.
973. C. pictipennis *Egg.*—Salix cin., S. Capr., S. aurit.
974. C. pigra *Loew.*—Anthrisc. sylv. (?)
975. C. plumulifera *Loew.*—Tarax. off. (?)
976. C. praecox *Zett.*—Potent. verna, Senec. Jacob., Tarax. off., Euphorb. Cypariss., Salix cin., S. Capr., S. aurit., S. rep.
977. C. pubera *Zett.*—Ranunc. acris, R. rep., R. bulb., R. lanugin., Caltha pal.
978. C. pulchripes *Loew.*—Pulmon. angustifol.
979. *C. schmidtii Zett.* (=C. antiqua *Mg.*, cf. No. 955).—Ranunc. acris, R. rep., R. bulb.
980. C. scutellata *Fall.* (cf. No. 982).—Aneth. graveol., Heracl. Sphond., Chaerophyll. temul., Solidago canad., Call. vulg., Polygon. Fagopyr.
981. C. soror *Zett.*—Daucus Car., Senec. Jacob., Hierac. Pilos.
982. *C. urbana Mg.* (=C. scutellata *Fall.*, cf. No. 980).—Salix. cin., S. Capr., S. aurit.
983. C. variabilis *Mg.*—Aegopod. Podagr., Angel. sylv., Daucus Car., Hypoch. rad.
984. C. vernalis *Fall.*—Ranunc. auricom., Tarax. off.
985. C. vidua *Mg.*—Ranunc. acris, R. rep., R. bulb.
986. C. sp.—Ranunc. Flamm., Caltha pal., Pap. Rhoeas, Arab. alb., Stell. med., Potent. Anser., P. sylv., Petrosel. sativ., Pimpin. Saxifr., Chaerophyll. Temul., Tussil. Farf., Senec. Jacob., Leont. hastil., Hypoch. rad., Achyroph. uniflor., Sonchus arv., Rheum undul., Euphorb. Cypariss., Cyprip. Calc. F±I±, Hyac. orient.

987. Chrysochlamys cuprea *Scop.*—Aegopod. Podagr.
988. C. ruficornis *F.*—Ranunc. acris, R. rep., R. bulb., Camp. Trach.
989. Chrysogaster aenea *Mg.*—Hesper. matron.
990. C. chalybeata *Mg.*—Aegopod. Podagr.
991. C. coemeteriorum *L.*—Fragaria elat., Ulmar. pentap., Conium macul., Aegopod. Podagr., Chaerophyll. Temul., Achill. Millef.
992. C. macquarti *Loew.*—Ranunc. acris, R. rep., R. bulb., Nasturt. sylv., Sinap. arv., Stell. med., Potent. Anser.
993. C. metallina *F.*—Ranunc. rep.
994. C. splendida *Mg.*—Pimpin. Saxifr., Euphorb. palustr.
995. C. viduata *L.*—Batrach. aquat., Ranunc. acris, R. rep., R. bulb., Spir. sorbif., S. salicif., S. ulmif., Aegopod. Podagr., Heracl. Sphond., Daucus Car., Picris hieracioid., Myosot. intermed.
996. C. sp.—Hypoch. radic.
997. Chrysotoxum arcuatum *L.*—Ranunc. acris, R. rep., R. bulb., Rubus frutic.
998. C. bicinctum *L.*—Caps. Bursa-past., Geran. pyren., Genista tinct. F±I±, Potent. sylv., Angel. sylv., Pastin. sat., Heracl. Sphond., Achill. Millef., A. Ptarm., Melampyr. prat.
999. C. elegans *Loew.*—Pastin. sat.
1000. C. fasciolatum *Deg.*—Helianth. vulg., Anthrisc. sylv.
1001. C. festivum *L.*—Ranunc. acris, R. rep., R. bulb., Spir. sorbif., S. salicif., S. ulmif., Aegopod. Podagr., Carum Carvi, Pimpin. Saxifr., Oenanthe aquat., Heracl. Sphond., Valer. off., Hypoch. rad., Jas. mont., Call. vulg., Convolv. arv., Plantago med., Polygon. Fagopyr., Euphorb. heliosc.
1002. C. octomaculatum *Curt.*—Heracl. Sphond., Hierac. Pilos., Call. vulg., Melampyr. sylv.
1003. C. vernale *Loew.*—Chrysophyll. Villarsii, Thym. Serp., Euphorb. Cypariss.
1004. Criorhina asilica *Fall.*—Euon. europ., Crat. Oxyac.
1005. C. berberina *F.*—Crat. Oxyac., Berb. vulg.
1006. C. floccosa *Mg.*—Crat. Oxyac., Salix sp.
1007. C. oxyacanthae *Mg.*—Crat. Oxyac., Salix sp.
1008. C. ruficauda *Deg.*—Salix incana.
1009. Didea alneti *Fall.*—Sanguis. off.
1010. D. intermedia *Loew.*—Hyper. perfor., Rosa can., Potent. sylv., Achyrophor. uniflor., Mulged. prenanthoid., Plantag. mont.
1011. Eristalis aeneus *Scop.*—Papaver. somnif., Arab. alb., Sinap. arv., Schiever. podol., Gypsoph. panic., Hyper. perfor., Fragaria vesca var. semperfl., Ulmar. pentap., Ribes Grossul., Carum Carvi, Pimpin. Saxifr., Sium latif., Heracl. Sphond., Scab. daucoid., Aster Tripol., A. azur., A. concinn., A. sagittifol., A. sparsifl., Galatella dracunculoid., Solidago fragr., Achill. Millef., Chrysanth. Leucanth., Doronic. caucas., Arnica Chamisson., Senec. nemor., S. Jacob., Cirs. arv., Centaur. nigra, Leont. aut., Hierac. umbell., Jas. mont., Mentha aquatica, Salix cin., S. Capr., S. aurit., Scilla ital., Muscari botr.
1012. E. alpinus *Panz.*—Vacc. Myrt.
1013. E. anthophorinus *Zett.*—Sinap. arv., Knaut. arv., Achill. Millef., Tanacet. vulg., Leont. aut.
1014. E. arbustorum *L.*—Clemat. recta, Thalictr. aquilegif., T. flavum, Anem. sylv., Batrach. aquat., Ranunc. acris, R. rep., R. bulb., R. Ling., R. lanugin., R. Fic., Caltha pal., Berb. vulg., Papaver somnif., Chelidon. majus, Nasturt. off., N. amphib., N. sylvest., Hesper. Matron., Sisymbr. austriac., Brass. nig., Sinap. arv., Berter. incana., Lepid. sat., Bunias orient., Cak. marit., Crambe pinnatif., Gypsoph. panic., Sperg. arv., Stell. Holost., S. med., Malach. aquat., Cerast. arv., C. triv., Tilia ulmif., Hyper. perfor., Acer Pseudoplat., Ulex europ. F±I+, Prunus dom., P. avium, P. cer., P. spin., Rosa can., Rubus caes., R. Id., Potent. Anser., P. rept., P. frutic., Ulmar. pentapet., U. Filip., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Pyrus comm., Sorb. Auc., Oenoth. bien. F+I+, Philad. coron., Scleranth. per., Sedum acre, Saxifraga longif., S. granul., Parnass. pal., Astrant. major, Eryng. camp., Conium macul., Petrosel. sat., Aegopod. Podagr., Carum Carvi, Sium latif., Bupleur. falcat., Oenanthe fistul., O. aquat., Conioselin. tataric., Ligustic. pyrenaic., Peucedan. Cervar., P. pal., P. ruthenic., Aneth. graveol., Heracl. Sphond., H. sibiric., Daucus Car., Anthrisc. sylv., A. Cerefol., Prangos ferulacea, Cornus sang., C. suecica,

Sambuc. nigra, Viburn. Opul., Symphoricarp. racem. F+I+, Galium verum, Valer. off., V. dioica, Knaut. arv., Succ. prat., Eupator. cannabin., E. ageratoid., E. purp., Aster Amell., A. Novae-Angl., A. salicif., A. floribund., A. laevis, A. lanceolat., A. Lindleyan., A. squarrulos., Biotia commixta, B. corymbosa, Chrysoc. Linosyr., Bellis per., Erigeron specios., Solidago Virgaur., S. canad., S. fragr., S. glabra, S. Missouriens., S. rigida, Inula Helen., I. britann., I. thapsoid., Pulicar. dysenter., Boltonia glastif., Coreops. auricul., Helichrys bracteat., Achill. Millef., A. Ptarm., A. dentifera, A. grandif., A. nobil., Anthem. arv., A. tinct., Matric. Chamom., M. inod., M. marit., Tanacet. vulg., Chrysanth. seget., C. Leucanth., Doronic. Pardalianch., D. austriac., Senec. nemor., S. nebrod., S. macrophyll., S. Jacob., Calend. off., Cirs. arv., C. lanceolat., Carduus crisp., Carlina acaul., Centaur. Cyan., C. argent., C. orient., Lamps. comm., Thrinc. hirta, Leont. aut., L. hastil., Picris hieracioid., Hypoch. radic., Tarax. off., Sonchus olerac., S. arv., Crep. bienn., Hierac. umbellat., Camp. rot., Jas. mont., Ligustr. vulg., Syringa vulg., Asclep. Syr. F+I+, Erythr. Centaur., Convolv. arv., C. sep., Myosot. sylv., M. intermed., Verbasc. thapsiforme, V. nigr., Linar. vulg., Plectranth. glaucocalyx, Mentha piperita, M. aquatica, M. sylv., Orian. vulg., Thym. Serp., Hotton. pal. F+I+, Plantag. med., Salsola Kali, Polygon. Fagopyr., P. Bistorta, R. Persic., Euphorb. Gerard., E. Cypariss., E. virgata, Mercur. ann., Salix cin., S. Capr., S. aurit., S. rep., Alisma Plant., Scilla campan.

1015. E. horticola *Deg.*—Sinap. arv., Hyper. perfor., Rosa can., Potent. sylv., Ulmar. pentapet., Sorb. Auc., Oenoth. Lamarck., Angel. sylv., Heracl. Sphond. Carum Carvi, Pimpin. Saxifr., Sambuc. nigra, Valer. off., Knaut. arv., Succ. prat., Eupator. cannabin., Tussil. Farf., Aster Tripol., Chrysanth. Leucanth., Senec. paludos., S. Jacob., Cirs. lanceolat., Serrat. tinct., Centaur. Scab., Leont. hastilis, Achill. Millef., A. Ptarm., Convolv. sep., Mentha aquat., Origan. vulg., Beton. off. (F+I+), Orchis mac. F+I+.

1016. E. intricarius *L.*—Ranunc. sceler., Caltha pal., Arab. aren., Cak. marit., Melilot. albus F+I+, Prunus spin., Rubus frutic., Potent. Anser., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Pyrus comm., Oenoth. Lamarck., Lythr. Sal. F+I+, Angel. sylv., Knaut. arv., Succ. prat., Scab. ochrol., S. daucoid., Artennar. margarit., Achill. Millef., Cacalia hastata, Cirs. arv., C. pal., Centaur. Jacea, C. rigidif., Leont. aut., Tarax. off., Mentha aquat., Nepeta Glechoma F+I+, Hotton. pal. F+I+, Armer. elong., Polygon. Fagopyr., P. Bist., Salix cin., S. Capr., S. aurit., S. rep.

1017. E. jugorum *Egg.*—Knaut. arv.

1018. E. nemorum *L.*—Clemat. Vitalba, Thalictr. aquilegif., T. flavum, Anem. sylv., Batrach. aquat., Ranunc. acris, R. rep., R. bulb., Caltha pal., Berb. vulg., Chelidon. majus, Nasturt. off., Cardam. prat., Hesper. matron., Brass. Rapa, Berter. incana, Lepid. sat., Caps. Bursa-past., Isat. tinctor., Helianth. vulg., Gypsoph. panic., G. perfol., Aren. graminif., Stell. Holost., Cerast. arv., Althaea cannab., Tilia ulmif., Hyper. perfor., Geran. pal., Euon. europ., Rhamn. cathart., Coron. var., Prunus spin., Geum riv., Fragaria collina, Potent. frutic., P. chrysantha, Agrim. Eupat., Ulmar. pentap., U. Filip., Spir. sorbif., S. salicif., S. ulmif., S. digit., Crat. Oxyac., Pyrus comm., Sorb. Auc., Oenoth. bienn. F+I+, O. biennis × O. muric., Circaea lutet. F+I+, Sicyos angul., Saxifr. decip., Parnass. palustr., Astrant. major, A. neglecta, Eryng. camp., Conium macul., Aegopod. Podagr., Sium. latif., Oenanthe fistul., Conioselin. tataric., Angel. sylv., Peucedan. cervar., P. ruthenic., Tommasin. verticill., Imperat. Ostruth., Aneth. graveol., Heracl. Sphond., H. Sibiric., Siler trilob., Anthrisc. Cerefol., Chaerophyll. temul., C. aureum, Myrrhis odor., Molopospermum. Peloponnes., Corrus sang., C. mas., Ebul. humile, Sambuc. nigra, Viburn. Opul., Asperula odor., Valer. off., Cephalaria radiata, Knaut. arv., Succ. prat., Scab. Columb., S. ochroi., Eupator. cannabin., E. ageratoid., Aster Amell., A. Amell. var. Bessarabic., A. salicif., A. abbreviat., A. azur., A. floribund., A. laevis, A. lanceolat., A. Lindleyan., A. phlogifol., A. sagittif., A. sparsifl., Biotia commixta, B. corymbosa, B. Schreberi, Galatella dracunculoid., Aster panicul., A. panic. var. pubescens, Chrysoc. Linosyr., Diplopapp. amygd., Solidago Virgaur., S.canad., S. ambigua, S. fragr., S. glabra, S. Missouriens., S. rigida, Silph. conat., S. erythrocaulon, Inula thapsoides, Helen. autumn., Boltonia glastifol., Helianth. atrorub., H. divaricat., Coreops. lanceol., Achill. Ptarm.,

A. Millef., A. grandifl., A. nobil., Anthem. arv., A. tinct., Matric. Chamom., Tanacet. vulg., Chrysanth. Seget., C. Leucanth., Doronic. Pardalianches, D. austriacum, Senecio nemor., S. sarracenicus, S. nebrod., S. macrophyll., S. Jacob., Echinops exaltat., Cirs. arv., C. lanceolat., Centaur. Jacea, C. Scab., C. argent., Lamps. comm., Leont. hastil., Picris hieracioid., Tragopog. floccos., Scorzon. parvifl., Hypoch. rad., Tarax. off., T. salin., Crep. bienn., C. rigida, Hierac. vulg., H. umbellat., H. crinit., Ligustr. vulg., Asclep. syr. F+I+, Myosot. alpestr., Mentha piperita, M. aquat., M. sylv.. M. sylv. var. nemorosa, Origan. vulg., Calamintha Nepeta, Teucr. Scorod. (F+I+), Hotton. pal. F+I+, Rheum undul., Polygon. Fagopyr., Euphorb. verrucosa, E. Cypariss., E. palustr., E. aspersa, E. nicaeens., Tulipa sylv., Scilla nut.

1019. E. pertinax *Scop.*—Thalict. aquilegif., Ranunc. Fic., Berb. vulg., Chelidon. majus, Arab. caucas., Hesper. matron., Sinap. arv., Cak. marit., Hyper. perfor., Ulex europ. F±I±, Medic. sat. F±I±, M. sylv., Rubus frutic., R. Id., Comarum pal., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Sorbus Auc., Philad. coron., Ribes Grossul., Parnass. pal., Angel. sylv., Heracl. Sphond., Daucus Car., Anthrisc. sylv., Chaerophyll. hirsut., Valer. off., Dipsac. sylv., Knaut. arv., Succ. prat., Eupator. cannabin., Tussil. Farf., Petasit. fragr., Bellis per., Solidago Virgaur., S. canad., Pulicar. dysenter., Achill. Millef., Matric. inod., Senec. nemor., Cirs. arv., Serrat. tinct., Centaur. nigra, Leont. aut., Tarax. off., Crep. bienn., Mentha aquat., Origan. vulg., Thym. Serp., Polygon. Fagopyr., Salix cin., S. Capr., S. aurit., S. rep., Narc. Pseud.-Narc. F±I±.

1020. E. rupium *F.*—Pimpin. Saxifraga, Heracl. Sphond., Knaut. arv., Succ. prat., Hierac. muror., Polygon. Bist.

1021. E. Sepulcralis *L.*—Clemat. recta, Thalictr. aquilegifol., T. flavum, Ranunc. acris, R. rep., R. bulb., Nasturt. off., Sinap. arv., Alyss. mont., A. saxat., Lepid. sat., Cerast. arv., Tilia ulmif., Hyper. perfor., Erod. cicut. var. pimpinellif., Ruta graveol., Rubus Id., Fragaria vesca, F. collina, Potent. multifida, P. frutic., Ulmar. pentap., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Sedum acre, Petroselin. sativ., Oenanthe fistul., Aneth. graveol., Heracl. Sphond., Daucus Car., Anthrisc. sylv., Chaerophyll. hirsut., Viburn. Opul., Galium Saxat., Valer. off., Centranth. angustif., Knaut. arv., Chrysoc. Linosyr., Bellis per., Pulicar. dysenter., Achill. Millef., A. Ptarm., Anthem. arv., Matric. Chamom., Chrysanth. Leucanth., Senec. nemor., S. Jacob., Cirs. arv., Centaur. Jacea, Lamps. commun., Cichor. Intyb., Thrinc. hirta, Leont. aut., Picris hieracioid., Hypoch. rad., Tarax. off., Crep. bienn., C. tector., Syringa vulg., Myosot. sylv., Veron. Beccab., Mentha arv., M. aquat., Satureia hort., Thym. Serp., Polygon. Fagopyr., P. Persic., P. lapathif., Alisma Plant.

1022. E. tenax *L.*—Clemat. Vitalba, C. recta, Thalictr. aquilegif., T. flavum, T. minus, Hepat. triloba, Anem. sylv., A. nemor., A. japon., Adon. vern., A. aestiv., Batrach. aquat., Ranunc. Flamm., R. acris, R. rep., R. bulb., R. Ling., R. auric., Hellebor. foetid., Berb. vulg., B. aquifol., Papaver somnif., Arab. bellidif., Hesper. matron., Brass. Rapa, B. nig., Sinap. arv., S. alba, Cak. marit., Crambe marit. (F+I+), Coron. Fl.-Jov., Sperg. arv., Stell. gramin., Althaea cannab., Hyper. perfor., Acer Pseudoplat., Geran. pal., Ruta graveol., Euon. europ., Staphl. pinn., Trif. arv. F+I+, Lotus corn. F±I±, Coron. varia ↓, Ornithop. sat., Amygd. comm., Prunus dom., P. avium, P. cer., P. spin., Rubus frutic., R. Id., Potent. verna, Alchem. acutilob., Agrim. Eupatorium, Ulmar. pentap., U. Filip., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Pyrus Malus, P. comm., Sorbus Auc., Epil. hirs., Oenothera bienn. F+I+, Lythr. hyssopif., Philad. coron., Bryon. dioica, Sedum acre, S. refl., S. spectab., Ribes Grossul., Saxifr. androsacea, Parnass. pal., Astrant. neglecta, Eryng. camp., E. plan., Cicuta virosa, Petroselin. sativ., Aegopod. Podagr., Pimpin. Saxifr., Conioselin. tataric., Peucedan. Cervar., Aneth. graveol., Heracl. Sphond., Daucus Car., Scandix Pecten-veneris, Chrysophyll. Villarsii, Hedera Helix, Cornus sang., Sambuc. nigra, Viburn. Opul., Sherard. arv., Valer. off., V. alliariif., Centranth. angustif., Cephalar. radiata, Knaut. arv., Succ. prat., S. austral., Scab. Columb., S. ochrol., S. atropurp., Eupator. cannabin., E. purp., Adenostyl. hybr., Tussil. Farf., Aster alpin., A. Tripol., A. Novae-Angliae, A. concinn., A. floribund., A. lanceolat., A. Lindleyan., A. sagittif., Biotia Schreberi,

Chrysoc. Linosyr., Bellis per., Diplopapp. amygd., Solidago Virgaur., S. canad., S. frag., S. Missouriens., Silphium asterisc., S. dentat., S. erythrocaulon, S. gummifer., S. perfoliat., S. terebinthinac., Pulicar. dysenter., Helen. aut., H. decurr., Boltonia glastif., Helianth. mutifl., H. atrorub., H. lactifl., H. trachelif., Chrysostemma tripteris, Coreopsis lanceol., Rudbeckia laciniata, Antennar. dioica, A. margaritacea, Achill. Millef., A. Ptarm., Anthem. arv., A. tinctor., A. rigescens, Matric. inod., Chrysanth. seget., Arnica Chamissonis, Cacalia hastata, Senec. nemor., S. Jacob., S. erucif., S. aquat., Calendula off., Cirs. arv., C. lanceolat., C. pal., Carduus crisp., C. acanthoid., C. nutans, Centaur. Jacea, C. nigra, C. Scab., C. rhen., C. caloceph., Cichor. Intyb., Thrinc. hirta, Leont. aut., L. hastil., Picris hieracioid., Tragopog. floccos., Scorzon. humil., Hypoch. rad., Tarax. off., Sonchus arv., Crep. bienn., C. virens, C. rigida, Hierac. Pilos., H. vulg., H. umbellat., H. bupleuroid., H. crinit., H. viros., Jas. mont., Call. vulg., Asclep. syr. F+I+, Phlox panicul., Convolv. arv., C. sep., Solanum tuberos., S. Dulcam., Veron. Beccab., Elssholzia crist., Mentha aquat., Origan. vulg., Lophant. rugos., Stach. sylv. F±I+, Ajuga rept. F±I+, Hotton. pal. F+I+, Armer. elong., Polygon. Fagopyr., P. amphib., P. Persic., Daphne Mez., Euphorb. heliosc., E. Cypariss., E. Esula, E. Pepl., E. dendroid., Mercur. ann., Salix cin., S. Capr., S. aurit., S. purp., S. rep., Stratiot. aloid., Commelina tuber., Allium Cepa, Colchic. aut.

1023. E. sp.—Adon. vern., Nasturt. off., Erysim. orient., Cochlear. Armorac., C. danica., Caps. Bursa-past., Cak. marit., Trif. rep. (F+I+), Circaea interm., Lythr. Sal. F+I+, Eryng. Bourgati, Carum Carvi, Oenanthe aquat., Symphoricarp. racem. F+I+, Lonic. Periclym., Adenost. alb., Helianth. ann., Matric. inod., Echinops sphaeroceph., Centaur. Scab., Cichor. Intyb., Jas. mont., Erica Tetr., Erythr. Centaur., Convolv. arv., Myosot. sylv., Calamintha off., Verben. off., Armer. elong., Plantag. med., Polygon. amphib., Daphne Mez., Hyacinth. orient., H. amethyst.
1024. Eumerus ovatus *Loew.*—Peucedan. Oreoselin.
1025. E. sabulonum *Fall.*—Gal. Moll., Achill. Millef., A. Ptarm., Jas. mont.
1026. E. sinuatus *Loew.*—Pastin. sat.
1027. Helophilus floreus *L.* (cf. No. 1058).—Clemat. recta, Anem. sylv., Batrach. aquat., Berb. vulg., Eschscholtzia californ., Nasturt. off., Sinap. arv., Lepid. sat., Tilia ulmif., Geran. pyren., Ruta graveol., Euon. europ., Rhus Cotinus, Medic. sat. F±I±, Rubus frutic., R. caes., R. Id., Potent. frutic., Ulmar. pentap., U. Filip., Spir. sorbif., S. salicif., S. ulmif., S. digit., Crat. Oxyac., Sorbus Auc., Philad. coron., Parnass. pal., Astrant. major, Eryng. camp., Conium macul., Petrosel. sat., Aegopod. Podagr., Carum Carvi, Sium latif., Aethusa Cynap., Conioselin. tatar., Angel. sylv., Peuced. pal., P. ruthen., Aneth. graveol., Heracl. Sphond., Daucus Car., Anthrisc. sylv., Chaerophyll. temul., C. aureum, Prangos ferul., Ebul. humile, Viburn. Opul., Symphoricarp. racem. F+I+, Valer. off., V. Phu, Scab. Columb., Eupator. purp., Aster Amell. var. Bessarab., A. salicifol., A. laevis, A. Lindleyan., A. sagittif., A. sparsifl., A. squarrul., Biotia commixta, Diplopapp. amygd., Solid. canad., S. fragr., S. glabra., S. Missouriens., S. rigida, Helenium autumn., Boltonia glastif., Rudbeckia laciniata, R. speciosa, Achill. grandif., A. Millef., A. Ptarm., Anthem tinct., Chrysanth. Leuc., Doronic. Pardalianch., D. austriac., Senecio macrophyll., Hierac. Pilos., H. umbellat., H. brevifol., H. crinit., Convolv. arv., Verbasc. Thapsus, Veron. off., Mentha piperita, M. aquatica, Origan. vulg., Satureia hort., Plantag. med., Rheum undul., Polygon. Fagopyr., Laurus nob., Euphorb. salicif.
1028. H. hybridus *Loew.*—Centaur. Jacea, Linar. Cymb.
1029. H. lineatus *F.*—Malach. aquat., Comar. pal., Veron. Anag., Utric. vulg. F+I+.
1030. H. lunulatus *Mg.*—Limnanth. nymph.
1031. * H. pendulus *L.*—Batrach. aquat., Ranunc. acris, R. rep., R. bulb., Berb. vulg., Chelidon. majus, Cardam. prat., Brass. Rapa, Helianth. vulg., Sperg. arv., Stellar. gram., Hyper. perfor., Geran. pal., G. sanguin., G. molle, G. iber., Erod. cicut., Rhus Cotinus, Melilot. albus F+I+, Prunus spin., Rubus frutic., R. caes., Potent. Anser., P. frutic., Crat. Oxyac., C. monog., Sorbus Auc., Lythr. Sal. F+I+, Ribes Grossul., Saxifr. umbrosa, Parnass. pal., Carum Carvi, Anthrisc. sylv., Cornus suec., Viburn. Opul., Valer. off.,

Knaut. arv., Succ. prat., Scab. lucida, Aster Novae-Angl., A. salicifol., A. Lindleyan., Solid. canad., Helichrys. bracteat., Achill. Millef., Anthem. tinct., Chrysanth. seget., C. Leucanth., Doronic. Pardal., Senec. Jacob., Cirs. arv., Centaur. Jacea, C. Cyan., C. Scab., Leont. aut., Hypoch. radic., Tarax. off., Hierac. vulg., H. bupleuroid., Jas. mont., Erica Tetr., Convolv. arv., C. sep., Lycopsis arv., Euphras. off., Mentha aquat., Armer. elong., Plantag. lanc.

1032. * H. trivittatus *F.*—Brass. nig., Hyper. perfor., Medic. falc., Sorb. Auc., Lythr. Sal. F+I+, Levistic. off., Knaut. arv., Scab. Columb., S. Dallaportae, Sc. daucoid., Aster alp., A. Lindleyan., Galatella dracunculoid., Solid. fragr., Helianth. tracheliifol., Senec. macrophyll., Tarax. off., Hierac. Pilos., Jas. mont., Echium vulg., Mentha aquat., Armer. elong., Salix rep.

1033. H. sp.—Cerast. arv., Myosot. sylv., Scrophul. aquat.

1034. Leucozona lucorum *L.*—Melandr. rubr., Tarax. off.

1035. Mallota fuciformis *F.*—Prunus spin., Crat. Oxyac.

1036. Melanostoma ambigua *Fall.*—Caltha pal., Sperg. arv., Salvia off. (F+I+), Plantag. med.

1037. M. barbifrons *Fall.*—Daucus Car., Galium sylv.

1038. M. gracilis *Mg.*—Raphan. Raph., Erod. cicut. var. pimpinellif., Astrant. major, Aster salicif.

1039. M. hyalinata *Fall.*—Anthrisc. sylv., Lonic. Periclym. ? F+I+, Echium vulg.

1040. M. mellina *L.* (cf. No. 1042).—Myosur. minim., Batrach. aquat., Ranunc. acris, R. rep., R. bulb., R. auric., R. lanugin., Chelidon. majus, Arab. aren., Cardam. prat., Stell. gramin., Cerast. arv., Hyper. perfor., Erod. cicut. var. pimpinellif., Staphyl. pinn., Lotus corn. F±I+, Geum urb., Sanguis. minor, Agrim. Eupat., Ulmar. pentap., Crat. Oxyac., Pyrus comm., Sorbus Auc., Circaea lutet. F+I+, C. interm., Lythr. Sal. F+I+. Saxifr. umbrosa, Parnass. pal., Carum Carvi, Heracl. Sphond., Chaerophyll. temul., C. aur., Aster alp., A. concinn., Chrysoc. Linosyr., Filago minima, Gnaphal. luteo-alb., Artem. Dracunc., Anthem. rigesc., Tanacet. vulg., Senec. vulg., Carduus crisp., Leont. aut., Mulged. macrophyll., Adenoph. styl., Jas. mont., Vincetox. Med., Apocyn. androsaemifol. F−I−, Veron. Cham., Mentha aquat., Galeops. Tet. F±I+, ? (F+I+), Plantag. lanc., P. med., P. mont., P. aren., Beta vulg., Euphorb. heliosc., E. Cypariss., P. palustr., Salix rep., Listera ov. F+I+, Alism. Plant.

1041. M. quadrimaculata *Verall.*—Anem. nemor., Ranunc. Fic., Ulex europ. F+I+, Chrysosplen. oppositif., Adoxa Moschat., Tussil. Farf., Petasit. fragr., Bellis per., Coryl. Avell., Salix Capr., S. vimin., S. purp.

1042. *Melanostoma scalare F.* (=Melanostoma mellina *L.* cf. No. 1040).—Daucus Car., Succ. prat., Jas. mont., Call. vulg., Stachys pal.

1043. M. sp.—Cichor. Intyb., Plantag. lanc.

1044. Melithreptus dispar *Loew.*—Cerast. arv., Agrim. Eupat., Jas. mont., Mentha sylv.

1045. M. formosus *Egg.*—Butom. umbell.

1046. M. menthastri *L.*—Sperg. arv., Geran. molle, Erod. cicut., Fragaria vesca, Potent. Anser., Sedum acre, Parnass. pal., Heracl. Sphond., Galium Moll., G. sylv., Anser prenanthoid., Leont. aut., Tarax. off., Jas. mont., Veron. Cham., Teucr. canum, Polygon. mite, P. avicul.

1047. M. nitidicollis *Zett.*—Statice Limon.

1048. M. pictus *Mg.*—Ranunc. acris, R. rep., R. bulb., Caps. Bursa-past., Gypsoph. panic., Hyper. perfor., Geran. prat., G. pyren., Erod. cicut. var. pimpinellif., Ruta graveol., Agrim. Eupat., Heracl. Sphond., Anthrisc. sylv., Polygon. mite.

1049. M. scriptus *L.* (cf. No. 1096).—Adon. vern., Ranunc. acris, R. rep., R. bulb., Arab. aren., Caps. Bursa-past., Crambe grandifl., Helianth. vulg., Cerast. arv., C. triv., Hyper. perfor., Geran. pal., Erod. cicut. var. pimpinellif., Medic. sat. F±I±, M. sylvestr., Desmod. canad., Geum urb., Potent. sylv., Agrim. Eupat., Saxifr. Aizoon, Parnass. pal., Aneth. graveol., Daucus Car., Anthrisc. sylv., Chaerophyll. temul., Asperula taur., Galium Moll., Knaut. arv., Aster sagittif., Chrysoc. Linosyr., Bellis per., Silphium erythrocaulon, Pulicar. dysent., Boltonia glastif., Helianth. divaricat., Coreops. lanceol., Gnaphal. lut.-alb., Senec. sylv., Centaur. Cyan., Picris hieracioid., Hypoch. radic., Crep. vir., Achill. Millef., A. Ptarm., Jas. mont., Call. vulg., Asclep. syr. F±I+, Convolv. arv., Myosot. alpestr., Solanum nigr., Mentha

arv., M. aquat., Lycopus europ., Salvia Verben., Stachys recta, Polygon. Fagopyr., P. Persic., Salix rep., Alism. Plant.

1050. M. strigatus *Staeg.*—Sperg. arv., Cerast. arv., Spir. sorbif., S. salicif., S. ulmif., Parnass. palustr., Jas. mont.

1051. M. taeniatus *Mg.*—Ranunc. Flamm., R. acris, R. rep., R. bulb., Chelidon. majus, Lepid. sat., Caps. Bursa-past., Helianth. vulg., Gypsoph. panic., Geran. pyren., Erod. cicut. var. pimpinellif., Potent. sylv., P. frutic., Agrim. Eupat., Lythr. Sal. (F+I+), Sedum acre, Parnass. pal., Aegopod. Podagr., Carum Carvi, Aster Tripol., Bidens tripart., Anthem. tinct., Tanacet. vulg., Chrysanth. Leuc., Cirs. arv., Leont. aut., L. hast., Picris hieracioid., Tragopog. prat., Tarax. off., Crep. vir., Achill. Millef., A. Ptarm., Camp. rot., Asclep. syr. F±I+, Convolv. arv., Euphras. off., Mentha arv., Origan. vulg., Stachys pal., Polygon. Persic.

1052. M. sp.—Nasturt. off., Teesdal. nudicaul., Melilot. albus, Trif. arv. ? F+I+, Galium Moll., Bellis per., Chrysanth. Leuc., Hier. umbellat., Myosot. alpestr.

1053. Merodon aeneus *Mg.*—Helianth. vulg., Geran. sanguin., G. dissect., Galium Moll., Thym. Serp., Antheric. ramos.

1054. M. albifrons *Mg.*—Heracl. Sphond.

1055. M. analis *Mg.*—Eryng. camp.

1056. M. cinereus *F.*—Ranunc. acris, R. rep., R. bulb., Leont. hast., Tarax. off., Thym. Serp.

1057. Microdon devius *L.*—Anthrisc. sylv., Echium vulg.

1058. *Myiatropa florea L.* (=Helophilus floreus *L.*, cf. No. 1027).—Origan. vulg.

1059. Orthoneura nobilis *Fall.*—Pimpin. Saxifr.

1060. Paragus bicolor *F.*—Fragaria vesca, Potent. arg., Chrysanth. Leucanth., Achill. Millef., A. Ptarm.

1061. P. cinctus *Schiner et Egg.*—Aethusa Cynap.

1062. P. tibialis *Fall.*—Medic. lupul., Senec. Jacob., Jas. mont.

1063. P. sp.—Daucus Car.

1064. Pelecocera scaevoides *Fall.*—Potent. aurea.

1065. P. tricincta *Mg.*—Geran. sanguin., G. pyren., Oenoth. Lamarck.

1066. Pipiza bimaculata *Mg.*—Camp. glomer.

1067. P. chalybeata *Mg.*—Ranunc. acris, R. rep., R. bulb., Lepid. sat., Echium rosulat., Salvia sclareoides, Nepeta macrantha F+I+, Lam. mac. ? F+I+.

1068. P. festiva *Mg.*—Sisymbr. austriac., Knaut. arv., Scab. ochrol., S. daucoid., Hierac. folios.

1069. P. funebris *Mg.*—Anem. sylv., Ranunc. acris, R. rep., R. bulb., Spir. sorbif., S. salicif., S. ulmif., Daucus Car., Hypoch. radic., Polygon. Fagopyr.

1070. P. geniculata *Mg.*—Aegopod. Podagr.

1071. P. lugubris *F.*—Chrysanth. Leucanth.

1072. P. noctiluca *L.*—Leont. hast. (?)

1073. P. notata *Mg.*—Ranunc. lanug., Crat. Oxyac.

1074. P. quadrimaculata *Pz.*—Ranunc. acris.

1075. P. tristis *Mg.*—Caltha pal.

1076. P. sp.—Geran. sanguin., Fragaria vesca, Jas. mont.

1077. Pipizella annulata *Macq.*—Bupleur. falcat., Heracl. Sphond., Daucus Car.

1078. P. virens *F.*—Ranunc. acris, R. rep., R. bulb., R. auric., Vit. ripar., Medic. lupul., Potent. Anser., Aegopod. Podagr., Carum Carvi, Angel. sylv., Heracl. Sphond., Lycium vulg., Salix rep.

1079. Platycheirus albimanus *F.*—Ranunc. acris, R. rep., R. bulb., Brass. Rapa, B. Nap., Melandr. rubr., Stellar. Holost., Hyper. perfor., Erod. cicut. var. pimpinellif., Medic. sat. F±I±, M. lupul., Prunus spin., Parnass. pal., Aegopod. Podagr., Daucus Car., Toril. Anthrisc., Anthrisc. sylv., Pulicar. dysenter., Doronic. Pardalianch., Centaur. nigra, Hypoch. radic., Call. vulg., Erica ciner., Mentha aquat., Stachys pal.

1080. P. clypeatus *Mg.*—Stell. med., Erod. cicut. var. pimpinellif., Potent. Anser., Galium Moll., Salix rep.

1081. P. fasciculatus *Loew.*—Erod. cicut. var. pimpinellif.

1082. P. manicatus *Mg.*—Ranunc. acris, R. rep., R. bulb., Caltha pal., Cerast. arv., C. triv., Medic. sat. F±I±, M. sylv., M. lupul. F+I+, Succ. prat., Eupator. cannab., Aster Tripol., Pulicar. dysent., Bidens tripart., Achill. Millef., Cirs. arv., Centaur. nigra, Leont. aut., Achyrophor. uniflor., Hierac. umb., Jas. mont., Call. vulg., Gent. Pneum., Mentha aquat., Salix rep., Narth. ossifr.

1083. P. peltatus *Mg.*—Ranunc. scler., Papaver somnif., Alliar. offic., Stellar. Holost., Hyper. perfor., Geran. pal., G. sylv., Potent. Anser., Carum Carvi, Angelica sylv., Knaut. arv., Centaur. Scab., Limnanth. nymph., Prun. grandifl.
1084. P. podagratus *Zett.*—Papaver Argem., Cak. marit., Cichor. Intyb.
1085. P. scutatus *Mg.*—Erod. cicut. var. pimpinellif., Medic. sat; F±I±, M. lupul., Chaerophyll. aur., Sherard. arv., Adenoph. styl., Apocyn. androsaemifol. F−I−, Gent. Pneum., Mentha aquat., Salvia prat. var. varieg. ↓
1086. P. sp.—Erysim. orient., Scleranth. per., Parnass. pal., Tussil. Farf., Serrat. tinct., Jas. mont., Verben. off., Stachys sylv. F±I+, Armer. elong.
1087. Pyrophaena ocymi *F.*—Ranunc. scelerat.
1088. P. rosarum *F.*—Potent. Anser.
1089. P. sp.—Carum Carvi.
1090. Plocota apiformis *Schr.*—Crat. Oxyac.
1091. Rhingia campestris *Mg.*—Cak. marit., Lythr. Sal. F+I+, Centaur. Jacea, Convolv. sep., Echium vulg., Scrophul. aquat., Utric. vulg. F+I+, Primul. viscosa.
1092. R. rostrata *L.*—Clemat. Vitalba, Thalictr. aquilegif., Anem. sylv., Ranunc. acris, R. rep., R. Ling., R. Fic., Caltha pal., Berb. vulg., B. aquif., Chelidon. majus, Cheiranth. Cheiri, Nasturt. amphib., Barbar. vulg., Turrit. glabra, Cardam. prat., Hesper. matron., Stenophragma Thalian., Alliar. off., Brass. oler., Sinap. arv., Berter. incana, Cak. marit., Raphanus Raphan., Viola tric. arv. F+I+, Coron. Fl.-cuc., Agrost. Gith., Stellar. Holost., Malach. aquat., Cerast. semidec., Malva sylv., Geran. pal., G. sanguin., G. pyren., G. rotundif., G. molle, G. pusill., G. Robert., Erod., cicut., Saroth. scop. F±I±, Prunus dom., P. avium, P. Cer., P. spin., Rubus frutic., R. Id., Geum riv., Fragaria vesca, Potent. verna, Agrim. Eupat., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Pyrus Malus, P. comm., Sorbus Auc., Lythr. Sal. F+I+, Philad. coron., Bryon. dioica (F+I+), Anthrisc. sylv., Lonic. tatar., L. Xylost. (F+I+), Asperula odor., Valer. dioica, Knaut. arv., K. sylv., Succ. prat., Scab. Columb., Bellis per., Cirs. pal., Centaur. Jacea, C. nigra, C. Cyan., Tarax. off., Camp. rapunculoid., C. Trach., Phyteum. nigr., Jas. mont., Erica Tetr., Syringa vulg., Phacelia tanacetif., Convolv. sep., Symphyt. off., Pulm. off., Echium vulg., Lithosperm. arv., Myosot. sylv., M. versicol., M. sparsifl., Solan. Dulcam., Verbasc. phoenic., Veron. Cham., V. mont., Mentha aquatica, Melissa off. F+I+, Nepeta Glech. F+I+, Lam. alb. F+I+, L. mac. F±I+, L. Galeobd. F+I+, Stachys sylv. F+I+, S. pal., Ballota nigra F±I+, Ajuga rept. (F+I+), Hotton. pal. F+I+, Plantag. med., Polygon. Fagopyr., P. Bist., Iris Pseudac., Polygonat. multifl.
1093. R. sp.—Crat. Oxyac., C. monog., Lonic. Periclym. F+I+.
1094. Sericomyia borealis *Fall.*—Rubus frutic., Angel. sylv., Knaut. arv., Succ. prat., Leont. aut., Achyrophor. unifl., Tarax. off., Call. vulg., Thym. Serp.
1095. S. lappona *L.*—Leont. hast., Vacc. uligin.
1096. *Sphaerophoria scripta L.* (=Melithreptus scriptus *L.*, cf. No. 1049).—Potent. sylv., Parnass. pal., Pimpin. Saxifr., Daucus Car., Succ. prat., Eupator. cannab., Pulicar. dysent., Achill. Millef., Matricar. inodora, Senec. Jacob., Centaur. nigra, Leont. aut.
1097. Sphegina clunipes *Fall.*—Moehr. musc., Saxifr. rotundif.
1098. Spilomyia diophthalma *L.*—Anthrisc. sylv.
1099. S. speciosa *Rossi.*—Paliur. acul.
1100. S. vespiformis *L.*—Tarax. off.
1101. Syritta pipiens *L.*—Clemat. recta, Thalictr. aquilegif., T. flavum, Anem. sylv., A. japon., Ranunc. Flamm., R. acris, R. rep., R. bulb., R. Ling., Chelidon. majus, Nasturt. off., N. amphib., N. sylv., Turrit. glabra, Arab. hirsuta, Sisymbr. Soph., S. austriac., Erysim. orient., Brass. Rapa, B. nig., Sinap. arv., Alyss. calyc., A. mont., Berter. incana, Lunar. ann. (F+I+), Cochlear. Armorac., C. danica, Lepid. sat., Caps. Bursa-past., Isat. tinctor., Cak. marit., Crambe marit. F±I±, C. pinnatif., Raphan. Raph., Res. odor., Viola tric. vulg. F+I±, Gypsoph. panic., G. perfol., Sperg. arv., Spergular. sal., Stell. gramin., S. med., Malach. aquat., Cerast. arv., C. triv., C. tetr., Hyper. perfor., H. quadrang., Aesc. Hippocast. F±I+, Vit. ripar., V. rup., Geran. pal., G. molle, Erod. cicut., Erod. cicut. var. pimpinellif., Ruta graveol., Ptelea trifol., Euon. europ., Rhus Cotinus, Medic. sat. F±I±, M. falc.,

M. sylv., M. lupul., Phaca alp., Prunus spin., Rubus frutic., R. Id., Fragaria vesca, F. vesca var. semperfl., Potent. rept., P. sylv., P. verna, P. frutic., P. chrysantha, Alchem. vulg., Sanguis. offic., Agrim. Eupat., Ulmar. pentapet., U. Filip., Spir. sorbif., S. salicif., S. ulmif., Arunc. sylv., Crat. Oxyac., C. monog., Pyrus Malus, P. comm., Sorbus Auc., Lythr. Sal. F+I+, Philad. coron., Sedum acre, S. Teleph., Ribes alp., Saxifr. decip., Parnass. pal., Astrant. major, Eryng. plan., Conium macul., Apium graveol., Petroselin. sativ., Aegopod. Podagr., Carum Carvi, Pimpin. Saxifr., Sium latif., Bupleur. falcat., Oenanthe fistul., O. aquat., O. crocata, Conioselin. tataric., Angel. sylv., Peucedan. ruthenic., Imperat. Ostruth., Aneth. graveol., Pastin. sat., Heracl. Sphond., Siler trilob., Daucus Car., Orlaya grandifl., Anthrisc. sylv., A. Cerefol., Chaerophyll. temul., C. aureum, Symphoricarp. racem. F+I+, Asperula cynanch., A. odor., Galium Moll., G. sylv., G. sylvest., G. verum, G. Aparine, G. saxat., Valer. off., V. asarifol., Centranthus ruber ? F±I±, Valerian. olit., Knaut. arv., Eupator.cannabin., E. ageratoid., E. purpur., Aster Amell. var. Bessarabic., A. Nov.-Angl., A. abbreviat., A. azur., A. concinn., A. floribund., A. Lindleyan., A. Novi Belg., A. paniculat., A. phlogifol., A. sagittifol., Biotia commixta, Chrysoc. Linosyr., Bellis per., Diplopapp. amygd., Solidago Virgaur., S. canad., S. ambigua, S. fragr., S. glabra, S. laterifl., S. Ridellii, S. rigida, Silphium Asteriscus, Pulicar. dysenter., Helenium decurrens, Boltonia glastifol., Helianth. divaricat., Coreops. auricul., C. lanceol., Rudbeckia laciniata, R. speciosa, Achill. Millef., A. Ptarm., A. filipend., A. grandif., A. tanacetif., A. tanacetif. var. dentifera, Anthem. tinct., A. rigesc., Matric. Chamom., M. discoid., Tanacet. vulg., T. (Pyrethrum) partheniifol., Chrysanth. seget., C. Leucanth., Doronic. Pardalianch., D. austriac., Senec. vulg., S. nemor., S. sarracen., S. nebrodens., S. macrophyll., S. Jacob., Echinops sphaeroceph., Cirs. arv., Serrat. tinct., Centaur. Cyan., C. caloceph., C. ruthen., Cichor. Intyb., Tragopog. floccos., Crep. bienn., Hierac. umb., H. crinit., H. hirsut., Lobel. Erin., Jas. mont., Call. vulg., Ledum pal., Syringa vulg., Apocyn. androsaemifol. F−I−, Echinosperm. Lapp., Echium rosulat., Lithosperm. arv., Myosot. sylv., M. intermed., M. versicol., Solanum tuberos., S. Dulcam., S. nigr., Verbasc. thapsiforme, V. nigr., Scrophul. nodosa F+I+, Linar. vulg. F±I+, L. striata, Veron. Cham., V. off., V. mont., V. Anagall., V. Beccab., Mentha arv., M. piperita, M. aquatica, M. sylv., M. sylv. var. Abyssin., Lycopus europ., Salvia Verbenaca, Origan. vulg., Satureia hort., Thym. vulg., Melissa off. (F+I+), Nepeta Catar. F+I+, Lophanth. rugos., Ballota nigra F±I+, Teucr. canum, Verben. off., Lysim. vulg. F+I+, L. thyrsifl., Samolus Valerandi, Armer. elong., Salsola Kali, S. Soda, S. crassa, Rheum undul., Polygon. Bist., P. Persic., P. lapathifol., P. mite, P. avicul., P. Convolv., Elaeagn. angustif., Buxus semperv., Euphorb. heliosc., E. Gerard., E. palustr., E. platyphyl., E. salicif., E. segetal., Mercur. ann., Salix cin., S. Capr., S. aurit., Alism. Plant., Commelina tuber., Scilla nut., Colchic. aut.

1102. S. sp.—Eryng. camp., Lonic. Periclym. F+I+.

1103. Syrphus albostriatus *Fall.*—Sisymbr. austriac., Cephalar. radiata, Echinops banat., Hierac. umbell.

1104. S. annulipes *Zett.*—Geran. sylv., Knaut. arv., Chrysanth. Leuc., Leont. aut., Achyrophor. uniflor.

1105. S. arcuatus *Fall.*—Cak. marit., Erod. cicut. var. pimpinellif., Potent. rept., Sedum refl., Cirs. arv., Sonchus olerac., Crep. vir., Echium vulg., Urtica dioic., Colchic. aut.

1106. S. balteatus *Deg.*—Clemat. Vit., Thalict. aquilegif., Anem. jap., A. japon. fl. purp., Ranunc. Ling., Berb. vulg., Chelid. majus, Erysim. orient., Cochlear. Armorac., Caps. Bursa-past., Res. odor., Gypsoph. panic., Sperg. arv., Stell. Holost., Malva Alc., Kitaib. vitif., Hyper. perfor., H. quadrang., H. tetrapt., Aesc. Hippocast. F±I+, Geran. pyren., Erod. cicut. var. pimpinellif., Impat. parvifl. F+I+, Medic. sat. F±I±, M. falc., M. sylv., M. lupul., Vicia pisiform. F±I±, Pyrus Malus, Epil. Fleisch., Lythr. Sal. F+I+, Bryonia dioica, Sedum acre, Parnass. pal., Conium macul., Aegopod. Podagr., Angel. sylv., Heracl. Sphond., Daucus Car., Cornus sang., Symphoricarp. racem. F+I+, Valer. off., Cephal. radiata, Succ. prat., Scab. ochrol., S. Hladnik., Vernon. fascicul., Chrysoc. Linosyr., Diplopapp. amygd., Solid. bicolor, S. glabra, S. Ridellii, Dahlia Cervantesii, Helen.

autumn., Bidens tripartit., Helianth. atrorub., H. decapetal., Coreops. lanceol., Rudbeckia lacin., Achill. Millef., Senec. nem., S. Jacob., Echinops exaltat., Cirs. arv., C. olerac., Carlina vulg., Centaur. Jacea, C. nigra, C. Scabiosa, C. Fontanesii, C. orient., Cichor. Intyb., Thrincia hirta, Leont. aut., L. hast., Picris hieracioid., Sonchus olerac., Tragopog. prat., T. floccos., Scorzon. hum., Hypoch. radic., Mulged. prenanthoid., Sonchus arv., Crep. vir., Hierac. Pilos., H. cymos, H. prat., Camp. Trach., Phyteum. canesc., Call. vulg., Erythr. Centaur., Convolv. arv., C. sep., Lycium vulg., Solanum tuberos., Verbasc. thapsiforme, V. Thapsus, V. nigr., Veron. Cham., Mentha arv., M. aquat., M. sylv., Origan. vulg., Melissa off. (F+I+), Stachys densif., Ajuga rept. F±I+, Lysim. vulg. F+I+, L. nemor., Plantag. med., Atripl. littor., Polygon. avicul., Euphorb. heliosc., Salix cin., S. Capr., S. aurit.

1107. S. cinctellus *Zett.*—Erod. cicut. var. pimpinellif., Potent. sylv., Angel. sylv., Pastin. sat., Senec. nem., Echinops banat., Achyrophor. uniflor.

1108. S. cinctus *Zett.*—Pastin. sat.

1109. S. confusus *Egg.*—Leont. hast. (?)

1110. S. corollae *F.*—Anem. japon. fl. purp., Sperg. arv., Stell. med., Erod. cicut. var. pimpinellif., Impat. parvifl. F+I+, Medic. sat. F±I±, M. sylvest., M. lupul., Trif. rep. F±I±, ? F±I+, Sorbus Auc., Saxifr. umbrosa, Eryng. plan., Aegopod. Podagr., Angel. sylv., Anthrisc. sylv., Symphoricarp. racem. F+I+, Scab. ucranica, Eupator. ageratoid., Aster Tripol., A. Amell., Diplopapp. amygd., Helianth. divaricat., Coreopsis lanceol., Rudbeckia lacin., Achill. Millef., Cacalia hast., Echinops banat., E. exaltat., Cirs. olerac., Centaur. Endressi, C. ruthen., Hypoch. radic., Achyrophor. uniflor., Hierac. umbellat., Lobel. Erin., Jas. mont., Convolv. sep., Pulmon. angustifol., Linar. vulg. F±I+, Mentha piperita, M. aquat., Stachys pal., Polygon. avicul., Euphorb. heliosc., E. Pepl., Mercur. ann., Salix cin., S. Capr., S. aurit., Colchic. aut.

1111. S. decorus *Mg.*—Alliar. off.

1112. S. diaphanus *Zett.*—Peucedan. Oreoselin. (?)

1113. S. excisus *Zett.*—Spir. sorbif., S. salicif., S. ulmif., Parnass. pal.

1114. S. glaucius *L.*—Aegopod. Podagr., Angel. sylv., Heracl. Sphond.

1115. S. grossulariae *Mg.*—Rubus frutic., Aegopod. Podagr.

1116. S. lasiophthalmus *Zett.*—Ranunc. Fic., Daucus Car., Tussil. Farf., Bellis per., Salix vimin.

1117. S. laternarius *Mill.*—Aegopod. Podagr.

1118. S. lineola *Zett.*—Erod. cicut. var. pimpinellif., Aegopod. Podagr., Pimpin. Saxifr., Centaur. rhen., Tarax. off.

1119. S. luniger *Mg.*—Ranunc. acris, Medic. falc., M. sylvest., Centranthus ruber †, Aster floribund., Coreops. auricul., Lactuca perenn., Veron. off., Melampyr. sylv., Nepeta Mussini.

1120. S. lunulatus *Mg.*—Clem. Vit., Ranunc. acris, R. rep., R. bulb., R. lanug., Ribes rubr., Achyrophor. uniflor., Melampyr. sylv., Salix cin., S. Capr., S. aurit.

1121. S. maculatus *Zett.*—Tussil. Farf.

1122. S. nitidicollis *Mg.*—Ranunc. lanugin., Cardam. prat., Ruta graveol., Aegopod. Podagr., Pimpin. Saxifr., Knaut. arv., Chrysanth. Leuc., Leont. aut., Tarax. off., Hierac. umbellat., Convolv. arv.

1123. S. pyrastri *L.*—Clemat. recta, Ranunc. acris, R. rep. R. bulb., Sinap. arv., Cak. marit., Helianth. vulg., Coron. Fl.-cuc., Cerast. arv., Geran. pyren., Erod. cicut. var. pimpinellif., Trif. rep. F±I±, ? F±I+, T. arv. F+I+, Vicia Faba F±I±, Potent. frutic., Crat. Oxyac., Pyrus Malus, Lythr. Sal. F+I+, Parnass. pal., Aegopod. Podagr., Levist. off., Angel. sylv., Aneth. graveol., Heracl. Sphond., Daucus Car., Valer. mont., Knaut. arv., Succisa prat., Chrysocoma Linosyr., Helianth. multifl., Echinops exaltat., Cirs. arv., Centaur. rhen., C. dealb., Leont. aut., Achyrophor. uniflor., Tarax. off., Sonchus arv., Crep. bienn., Jas. mont., Call. vulg., Convolv. sep., Echium vulg., Veron. Cham., Mentha aquat., Salvia off. (F+I+), Origan. vulg., Nepeta macrantha F+I+, Teucr. canum, Polygon. Fagopyr., Buxus semperv., Salix cin., S. Capr., S. aurit., Lilium cand., Eremur. altaic., Colchic. aut.

1124. S. ribesii *L.*—Clemat. Vitalba, Anem. japon., Ranunc. acris, R. rep., R. bulb., R. Ling., R. lanugin., Berb. aquif., Papaver Rhoeas, Glaucium flavum,

G. cornicul., Chelidon. majus, Eschscholtzia californ., Sinap. arv., Berter. incana, Crambe marit. (F+I+), Raphan. Raph., Helianth. vulg., Sperg. arv., Stell. Holost., S. med., Hyper. perfor., H. quadrang., Acer. Pseudoplat., Geran. pyren., Impat. parviflor. F+I+, Ruta graveol., Euon. europ., Staphyl. pinn., Medic. sat. F±I±, M. sylvestr., Rubus frutic., R. caes., R. Id., Potent. Anser., Agrim. Eupat., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Epil. angust., Gaura bienn., Lythr. Sal. F+I+, Philad. coron., Sicyos angul., Ribes Grossul., Parnassia palustr., Astrant. major, Eryng, marit., E. camp., Conium macul., Aegopod. podagr., Carum Carvi, Pimpin. Saxifr., Sium latif., Oenanthe crocata, Heracl. Sphond., Siler trilob., Dauc. Carota, Anthrisc. sylv., Chaerophyll. aur., Sambuc. nigra, Symphoricarp. racem. F+I+, Galium Moll., Valerian. olit., Cephalar. rad., C. uralens., Knaut. arv., Succ. prat., Scab. Columb., S. ochrol., Eupator. cannab., E. purp., Aster abbrev., A. Amell. var. Bessarab., A. lanceol., A. panicul., A. pan. var. pubescens, Biotia commixta, Chrysoc. Linosyr., Diplopapp. amygd., Solidago canad., Silphium terebinth., Inula thapsoid., Pulicar. dysenter., Boltonia glastif., Helianth. multifl., Coreops. auricul., Artem. Absinthium, Anthem. tinct., Tanacet. vulg., Cacalia hast., Senec. nemor., S. Jacob., Calend. off., Cirs. arv., C. pal., Carduus nutans, Serrat. tinct., Centaur. microptilon, Cichor. Intyb., Leont. aut., L. hast., L. asper, Tarax. salin., Sonchus arv., Crep. vir., Achill. Millef., A. Ptarm., Jas. mont. Convolv. sep., Myosot. palustr., Verbasc. Thapsus, Veron. longifol., Euphras. off., Mentha arv., M. aquat., Lycop. europ., Origan. vulg., Plantag. lanc., P. med., Polygon. Bist., Hippoph. rhamn., Salix cin., S. Capr., S. aurit., S. rep., Alism. Plant., Tulipa sylv.

1125. S. seleniticus *Mg.*—Heracl. Sphond.
1126. S. topiarius *Mg.*—Hyper. perfor., Senec. Jacob., Achyrophor. uniflor.
1127. S. tricinctus *Fall.*—Cirs. pal., Tarax. off.
1128. S. trilineatus *L.*—Rubus caes., Parnass. pal.
1129. S. umbellatorum *F.*—Papaver Rhoeas, Sinap. arv., Cak. marit., Eryng. marit., Heracl. Sphond., Daucus Car., Serrat. tinct., Cichor. Intyb.
1130. S. venustus *Mg.*—Ranunc. lanugin., Brass. Rapa, B. Napus, Tarax. off.
1131. S. vitripennis *Mg.*—Origan. vulg.
1132. S. vittiger *Zett.*—Anthrisc. sylv., Tarax. off. (?)
1133. Syrphus sp.—Thalictr. minus, Batrach. aquat., Ranunc. acris, R. rep., R. bulb., Caltha pal., Papaver somnif., Nasturt. sylv., Raphan. Raph., Malach. aquat., Hyper. perfor., Geran. Robert., Frag. vesca, Potent. verna, Circaea lutet. F+I+, Sedum acre, Apium graveol., Carum Carvi, Oenanthe aquat., Lonic. Periclym. F+I+, Scab. atropurp., Solid. Virgaur., Cirs. arv., Leont. aut., Crep. bienn., Lobel. Erin., Jas. mont., Call. vulg., Solanum Dulcam., Scrophul. aquat., Euphras. off., Ballota nigra F±I+, Verben. off., Hotton. pal. F+I+, Plantag. med., Rheum Rhapont., Euphorb. dendroid.
1134. Tropidia milesiformis *Fall.*—Cak. marit., Comar. pal., Aegopod. Podagr., Galium boreale.
1135. * Volucella bombylans *L.*—Raphan. Raph., Dianth. delt., Coron. Fl.-cuc., Stell. gramin., Tilia ulmif., Melilot. albus F+I+., Trif. rep. F+I+, T. prat., T. med., Rubus frutic., Potent. Anser., P. rept., P. frutic., Ulmar. pentap., Lythr. Sal. F+I+, Philad. coron., Angel. sylv., Heracl. Sphond., Chrysophyll. Villarsii, Valer. off., Knaut. arv., Achill. Millef., A. Ptarm., Cirs. arv., C. pal., Centaur. Cyan., C. rhen., Leont. aut., Jas. mont., Call. vulg., Erica Tetr., Solan. Dulcam., Origan. vulg., Thym. Serp., Stachys Beton. (F+I+), Armer. elong., Orchis. mac. F+I+, Antheric. ramos.
1136. V. bombylans *L.* var. bombylans *Mg.*—Crep. bienn.
1137. * V. bombylans *L.* var. plumata *Mg.* (cf. No. 1141).—Onobr. viciif., Rubus frutic., Spir. sorbif., S. salicif., S. ulmif., Lythr. Sal. F+I+, Knaut. arv., Cirs. arv., Jas. mont.
1138. *V. haemorrhoidalis Zett.* (=V. bombylans *L.* var. haemorrhoidalis *Zett.*).—Erica Tetr.
1139. V. inanis *L.*—Rubus frutic., Aegopod. Podagr., Valer. off., Inula Helenium, Senec. nemor., Cirs. arv., C. pal., Mentha sylv., Origan. vulg., Thym. Serp.
1140. V. pellucens *L.*—Ranunc. lanugin., Hesper. matron., Tilia ulmif., Rubus frutic., R. Id., Potent. frutic., Ulmar. pentap., Philad. coron., Aegopod. Podagr., Pimpin. Saxifr., Angel. sylv., Heracl. Sphond., Anthrisc. sylv., Corn. sang., Valer. off., Dipsac. sylv., Cephal. ural., Knaut. arv., Succ. prat.,

Scab. ochrol., S. Hladnik., Chrysanth. Leucanth., Cacalia hast., Cirs. arv., Leont. hast., Achill. Millef., A. Ptarm., Mentha aquat., Origan. vulg., Thym. Serp., Plantag. lanc., P. med.

1141. *V. plumata Mg.* (=V. bombylans *L.* var. plumata *Mg.*, cf. No. 1137).—Coron. Fl.-cuc., Knaut. arv., Succ. prat., Erica Tetr., Origan. vulg.
1142. Xanthogramma citrofasciata *Deg.*—Euon. europ., Alchem. vulg., Petroselin. sativ.
1143. Xylota femorata *L.*—Myrrhis odor.
1144. X. florum *F.*—Heracl. Sphond.
1145. X. ignava *Pz.*—Clem. recta, Spir. sorbif., S. salicif., S. ulmif., Anthrisc. sylv.
1146. X. lenta *Mg.*—Clem. recta, Spir. sorbif., S. salicif., S. ulmif., Anthrisc. sylv.
1147. X. segnis *L.*—Erod. cicut. var. pimpinellif., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Heracl. Sphond., Syringa vulg.
1148. X. sylvarum *L.*—Stachys sylv. F+I+.
1149. X. triangularis *Zett.*—Tarax. off.
1150. X. sp.—Senec. nemor.

V. Tabanidae.

1151. Chrysops caecutiens *L.*—Sinap. arv., Gypsoph. panic., Potent. frutic., Spir. sorbif., S. salicif., S. ulmif., Pimpin. Saxifr., Thym. Serp.
1152. Haematopota pluvialis *L.*—Knaut. arv.
1153. Silvius vituli *F.*—Eupator. cannabin.
1154. Tabanus auripilus *Mg.* var. aterrimus *Mg.*—Daucus Car.
1155. T. borealis *F.*—Imperator. Ostruth., Chaerophyll. Villarsii.
1156. T. bovinus *L.*—Tilia ulmif.
1157. T. bromius *L.*—Peucedan. Oreoselin., Cirs. arv.
1158. T. infuscatus *Loew.*—Angel. sylv.(?), Peucedan. Oreoselin., Daucus Car.
1159. T. luridus *Fall.*—Valer. off.
1160. T. micans *Mg.*—Pimpin. Saxifr., Heracl. Sphond., Anthrisc. sylv.
1161. T. rusticus *L.*—Heracl. Sphond., Knaut. arv., Cirs. arv., Achill. Millef., A. Ptarm., Jas. mont., Echium vulg., Thym. serp., Allium rot.
1162. T. tropicus *L.*—Ajug. rept. ? F±I+.
1163. T. sp.—Thym. Serp.

W. Therevidae.

1164. Thereva anilis *L.*—Potent. Anser., Aegopod. Podagr., Carum Carvi, Anthrisc. sylv., Galium Moll.
1165. T. microcephala *Loew.*—Euphorb. Cypariss.
1166. T. nobilitata *Fabr.*—Galium Moll., Angel. sylv.
1167. T. praecox *Egg.*—Crat. Oxyac.
1168. Xestomyza kollari *Egg.*—Rubus frutic.

X. Tipulidae.

1169. Pachyrhina crocata *L.*—Aegopod. Podagr., Anthrisc. sylv., Galium Moll.
1170. P. histrio *F.*—Aegopod. Podagr., Heracl. Sphond.
1171. P. pratensis *L.*—Spir. sorbif., S. salicif., S. ulmif., Anthrisc. sylv.
1172. P. scurra *Mg.*—Carum Carvi.
1173. P. sp.—Euphorb. heliosc.
1174. Ptychoptera contaminata *L.*—Anthrisc. sylv.
1175. Tipula oleracea *L.*—Rubus frutic., Parnass. pal.
1176. T. sp.—Carum Carvi, Aneth. graveol., Myrrhis odor., Valer. dioica.

IV. HYMENOPTERA

A. Apidae.

1177. Ammobatus vinctus *Gerst.*—Centaur. Biberst.
1178. Andrena aeneiventris *Mor.*—Orlaya grand.
1179. *A. aestiva Sm.* (=bicolor *F.*, cf. No. 1190).—Campan. rapunculoid., Erythr. Cent., Polygon. Fagop.
1180. A. albicans *Müll.*, ♀ 3–3½, ♂ 2–2½ mm.—Clemat. Vitalba, C. recta, Anem. nem., Ranunc. acris, R. rep., R. bulbos., R. Fic., Caltha pal., Berb. vulg., Papav. nudicaule, Nasturt. sylv., Arab. aren., Cardam. impat., Hesper. matron., Brass. oler., B. Rapa, Sinap. arv., Cochlear. Armorac., Iber. amara, Viola odor., V. tric. vulg. F+I±, Polyg. com., Stell. med., Cerast. arv., Acer Pseudoplat., Rhus Cotinus, Cytis. Lab. F+I+, Persica vulg., Prunus dom.,

P. avium, P. Cer., P. cerasif., P. insititia, P. spin., Rosa can., Rubus frutic., R. Id., Potent. Anser., P. verna, Spir. sorbif., S. salicif., S. ulmif., S. opulif., Crat. Oxyac., C. monog., Cydonia jap., Pyrus Malus, P. comm., Sorbus Auc., Philad. coron., Ribes alp., R. Gross., Astrant. maj., Aegop. Podagr., Carum Carv., Anthrisc. sylv., Corn. sang., Viburn. Opul., Lonic. tatar., Valer. off. var. altiss., Valer. dioica, Valerianel. olit., Tussil. Farf., Achill. Millef., A. Ptarm., Tarax. off., Crep. bien., Hierac. Pilos., Vacc. Myrt., Myosot. sylv., M. interm., Linar. Cymb. F+I+, Nepeta Glech. F±I±, Lam. alb. ♀ F+I+, Polygon. Bist., Euphorb. aspera, Salix Capr., S. cin., S. aurit., S. alba, S. fragil., S. triand., S. vimin., S. rep., Cyprip. Calc. ♀ F+I+, Gagea bracteol., G. spath., Scilla sibir., Hyac. orient.

1181. A. albicrus *K.* 3 mm.—Ranunc. acris, R. rep., R. bulb., Cheiranth. Cheiri, Nasturt. sylvest., Arabis paucifl., Brass. Rapa, B. Nap., Sinap. arv., Iber. amara, Viola odor., Sperg. arv., Stell. med., Genista tinct. F+I+, Prunus Cer., P. spin., Rubus frutic., R. Id., Potent. Anser., P. rept., P. verna, Spir. sorbif., S. salicif., S. ulmif., Aruncus sylv., Crat. Oxyac., Pyrus Malus, Sorbus Auc., Aegop. Podagr., Tussil. Farf., Hypoch. radic., Tarax. off., Crep. rubra, Hierac. Pilos., Campan. rot., Echium vulg., Polygon. Fagopyr., Salix cin., S. Capr., S. aurit., S. alba, S. fragil., S. triand., S. vimin., S. rep., Gagea stell.

1182. A. albofasciata *Thoms.*—Muscari racemos.

1183. A. albopunctata *Rossi* (=*A. funebris Pz.*).—Cheiranth. Cheiri, Nasturt. lippic., Res. lutea, Malva sylv., Lotus corn., Rubus frutic., Thym. Cham., T. dalm.

1184. A. alpina *Mor.*—Campan. rot., C. Trach.

1185. A. angustior *K.* (=*A. symphyti* (*Pér.*) *Schmiedekn*).—Tarax. off., Hierac. Pilos.

1186. A. apicata *Sm.*—Sorbus Auc., Ribes aureum, Tussil. Farf., Tarax. off., Salix cin., S. Capr., S. aurit., S. alba, S. fragil.

1187. A. argentata *Sm.* 2–2½ mm. (cf. No. 1238).—Brass. oler., B. Rapa, B. Nap., Cerast. arv., Prunus Cer., Potent. sylv., P. verna, Heracl. Sphond., Achill. Millef., A. Ptarm., Leont. aut., Tarax. off., Hierac. Pilos., Jas. mont., Call. vulg., Salix cin., S. Capr., S. aurit., S. alba, S. fragil., S. rep.

1188. *A. atriceps K.* (=A. tibialis *K.*, cf. No. 1304), 3½ mm.—Berb. vulg., Prunus spin., Crat. Oxyac., Sorbus Auc., Tarax. off., Vacc. uligin., Salix cin., S. Capr., S. aurit., Cyprip. Calc. ♀ F+I+.

1189. A. austriaca *Pz.* (cf. Nos. 1283 and 1314).—Ranunc. acris, R. rep., R. bulb., Paliur. acul., Rubus frutic., Pastin. sat., Heracl. Sphond., Dauc. Car., Cirs. arv., Salix sp.

1190. *A. bicolor F.* (=A. gwynana *K.* (2nd gen.), cf. Nos. 1179, 1239-41).—Ranunc. acris, R. rep., R. bulb., Polygon. Fagop.

1191. A. bimaculata *K.* (cf. No. 1213).—Prunus spin., Rubus frutic., Succ. prat., Cirs. arv., Picr. hierac., Salix sp.

1192. A. braunsiana *Friese.*—Linum austr., Veron. spic.

1193. A. bucephala *Steph.*—Acer Pseudoplat., Prunus spin., Salix sp.

1194. A. carbonaria *L.* (cf.-No. 1275).—Cheiranth. Cheiri, Nasturt. lippic., Sisymbr. orient., Brass. oler., B. Rapa, B. Nap., Sinap. arv., Lepid. sat., Myagr. perfol., Raphan. sat., Trif. arv. ♂ F+I+, Coron. Emerus, Prunus spin., Rubus frutic., Crat. Oxyac., Ribes Gross., Tordyl. apul., Cornus sang., Bellis per., Tanac. Parth., Senec. Jacob., Centaur. aren., Tarax. off., Eric. arb., Ligustr. vulg., Thym. Cham., T. dalm., Rosmar. off., Marrub. vulg. F+I+, M. candidiss., Ajug. genev., Armer. elong., Salix aurit., S. alba, S. fragil.

1195. *A. cetii Schr.* (=A. marginata *F.*, cf. No. 1255).—Succ. prat., Scab. Columb., S. ochrol., Onopord. Acanth.

1196. A. chrysopyga *Schenck.*—Stell. Holost., Crep. tector., Hierac. Pilos., Veron. Cham.

1197. A. chrysosceles *K.*—Brass. Rapa, Stell. med., Crat. Oxyac., Anthrisc. sylv. Achill. Millef., A. Ptarm., Tarax. off., Veron. Cham., Salix cin., S. Capr. S. aurit., S. alba, S. fragil., S. vimin., S. purp., Gagea fascic.

1198. A. cineraria *L.* (cf. No. 1235), 4 mm.—Ranunc. Fic., Arab. aren., Cardam. prat. Brass. Rapa, B. Nap., Stell. Holost., Cerast. arv., Melilot. albus F+I+ Crat. Oxyac., Ribes Gross., Tarax. off., Prim. elat., Salix Capr., S. cin. S. aurit., S. alba, S. fragil., S. vimin., S. rep.

1199. A. cingulata *F.*—Ranunc. acris, R. rep., R. bulb., R. lanugin., Arab. aren. Brass. Rapa, B. Nap., Sinap. arv., Stell. Holost., Geran. pusill., Potent

verna, Sorbus Auc., Bryon. alba, Sedum acre, Tarax. off., Conv. arv., Veron. Cham., V. arv.

1200. A. clarkella *K.*—Ranunc. Fic., Ulex europ. F+I+, Potent. steril., Tussil. Farf., Bellis per., Tarax. off., Veron. Tournef., Salix Capr., S. cin., S. alba, S. fragil., S. vimin., S. monandr., Narc. Pseud.-Narc. F±I±.

1201. *A. coitana K.* (=A. shawella *K.*, cf. No. 1294).—Malva mosch., Geran. prat., Ulmar. pentap., Heracl. Sphond., Cirs. pal., Leont. hast., Hierac. vulgat., Campan. rot., C. Trach., C. pat., Jas. mont., Digit. purp., D. ambig., Thym. Serp., Galeops. Tetr. F±I+.

1202. A. colletiformis *Mor.*—Paliur. acul.

1203. *A. collinsonana K.* (=A. proxima *K.*, cf. No. 1280).—Pyrus comm., Anthrisc. sylv., Valerian. olit., Senec. Jacob., Salix cin., S. Capr., S. aurit.

1204. A. combinata. *Chr.* (cf. No. 1216).—Nasturt. lippic., Brass. Rapa, Prunus avium, Crat. Oxyac., Ribes Gross., Aegop. Podagr., Dauc. Car., Symphoric. racem. F+I+, Artemis. Absinth., Leont. aut., Tarax. off., Pentstem. pubesc., P. orat., P. procer., Salix sp.

1205. A. congruens *Schmiedekn.*—Prunus spin., Tarax. off., Salix aurit.

1206. *A. connectens K.* (=? A. convexiuscula *K.*).—Crat. Oxyac., Tarax. off., Salix cin., S. Capr., S. aurit.

1207. *A. convexiuscula K.* (=A. afzeliella *K.*, A. similis *Sm.*, and A. xanthura *K.*).—Aquileg. vulg., Nasturt. lippic., Brass. oler., B. Rapa, Thlaspi praec., Res. lutea, Cist. vill., Sperg. arv., Genista angl. F+I+, Cytis. sagitt., Medic. sat. ♀ F+I+, M. lupul. ♀ F+I+, Melilot. altiss. F+I+, Trif. prat. ♀ F+I+, ♂ F±I+, T. med., Lotus corn. ♀ F+I+, Vicia sep., V. Faba ♀ F+I+, V. hirs. ♂ F+I+, Lathyr. mont. ♀ and ♂ F+I+, Pyrus Malus, Sorbus Auc., Ribes Gross., Dauc. Car., Symphoric. racem. ♂ F+I+, Valerian. olit., Knaut. arv., Succ. prat., Senec. Jacob., Hypoch. radic., Tarax. off., Hierac. Pilos., Phyteum. nigr., Vacc. Myrt., Veron. Cham., Thym. Cham., Lam. alb., Stach. sylv., S. arv., Prun. vulg., Empetr. nigr., Euphorb. Cypar., Salix alba, S. fragil., S. rep.

1208. A. convexiuscula *K.* var. fuscata *K.*—Res. lutea, Dorycnium hirs., Anthem. arv., Thym. Cham., T. dalm., Stach. recta, Ajug. genev.

1209. A. croatica *Friese.*—Salix sp., Muscari racemos.

1210. A. curvungula *Thoms.* (cf. No. 1244).—Aquil. vulg., Astrag. Onobrych., Campan. rot., C. glom., C. pat.

1211. A. cyanescens *Nyl.*—Cist. vill., C. monspel., C. salviif., Lotus corn., Potent. verna, Anthem. arv., Hierac. Pilos., Veron. Cham., Stach. ital.

1212. A. deceptoria *Schmiedekn.*—Thlaspi praec., Myagr. perfol., Raphan. sat., Lotus corn., Prunus spin., Vinca min., Thym. dalm.

1213. *A. decorata Sm.* (2nd gen.), (=A. bimaculata *K.*, cf. No. 1191).—Sisymbr. orient.

1214. A. denticulata *K.*—Sinap. arv., Medic. falc., Trif. arv. ♂ F+I+, Potent. sylv., Heracl. Sphond., Solidag. Virgaur., S. canad., Achill. Millef., A. Ptarm., Tanac. vulg., Senec. Jacob., Cirs. pal., Centaur. nigr., Thrinc. hirt., Leont. aut., Hypoch. radic., Prenanth. purpur., Crep. bien., C. vir., C. tector., Hierac. vulgat., H. muror., Jas. mont., Veron. Tournef., Euphras. Odont., Lysim. vulg.

1215. *A. distinguenda Schenck.* (=A. lepida *Schenck.*, cf. No. 1252).—Caps. Bursa-past.

1216. *A. dorsata K.* (2nd gen.), (=A. combinata *Chr.*, cf. No. 1204), 3 mm.—Papaver Rhoeas, Cardam. prat., Sisymbr. off., S. austriac., Brass. Rapa, B. Nap., Sinap. arv., Stell. med., Hyper. perfor., Geran. pal., G. pyren., Lupin. polyph., Melilot. altiss. ♀ F+I+, Trif. med., T. pannon., Astrag. monspess., Vicia onobrychoid., Prunus spin., Rubus frutic., Fragaria vesca, Potent. arg., P. verna, Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Sorbus Auc., Philad. coron., Aegop. Podagr., Aneth. grav., Anthr. sylv., Achill. Millef., A. Ptarm., Senec. Jacob., Cirs. arv., Tarax. off., Crep. bien., C. vir., Jas. mont., Call. vulg., Verbasc. phoenic., Nepeta Muss. F+I+, Polygon. Fagop., P. Pers., Euphorb. aspersa, Salix cin., S. Capr., S. aurit.

1217. *A. dragana Friese.* (=A. spinigera *K.*, cf. No. 1298).—Salix sp.

1218. A. dubitata *Schenck.*—Cist. salviif., Geran. molle, Dorycnium herbac., Trif. rep. F+I+, Heracl. Sphond., Thym. Cham., Salix aurit.

1219. A. eximia *Sm.* 3½ mm.—Stell. med., Prunus spin., Centaur. Scab., Eric. carn., Salix aurit., S. Capr., S. cin., S. alba, S. fragil., S. purp., S. monandr., S. pentandr.

1220. A. extricata *Sm.* (cf. No. 1221).—Ranunc. Fic., Barbar. vulg., Brass. oler., B. Rapa, Medic. sat. ♂ F+I+, Prunus spin., Tarax. off., Salix aurit., S. Capr., S. alba, S. fragil., S. vimin., Tulipa sylv.

1221. *A. fasciata Wesm.* (=A. extricata *Sm.*, cf. No. 1220) 3–4 mm.—Stell. med., Medic. med., Trif. prat. ♀ F+I+, ♂ F±I+, Prunus Armen., P. spin., Philad. coron., R. Gross., Aegopod. alpestre, Doronic austriac., Tarax. off., Myosot. interm., Euphorb. pal., Salix cin., S. Capr., S. aurit., Ornithog. umb., Polygon. multifl.

1222. A. ferox *Smith.*—Crat. Oxyac.

1223. A. flavipes *Pz.* (cf. No. 1233).—Ranunc. acris, R. rep., R. bulb., R. Fic., Cheiranth. Cheiri, Nasturt. lippic., Brass. Rapa, B. Nap., Sinap. arv., Caps. Bursa-past., Myagr. perfol., Bunias Erucago, Raphan. sat., Geran. molle, Paliur. acul., Spartium junc., Onon. spin. ♀ F+I+, Melilot. albus F+I+, Trif. rep. F+I+, T. nigresc., Lotus corn., Coron. Emerus, Prunus spin., Sorbus Auc., Ribes Gross., Heracl. Sphond., Tussil. Farf., Achill. Millef., Senec. Jacob., Cirs. arv., Leont. aut., Tarax. off., Crep. bien., Jas. mont., Veron. Cham., Salvia Bertol., Thym. Serp., T. dalm., Rosmar. off., Ajug. genev., Salix Capr., S. alba, S. fragil.

1224. A. figurata *Mor.*—Conium mac.

1225. A. flessae *Pz.*—Cheiranth. Cheiri, Brass. Rapa, Res. lutea, Melilot. altiss. F+I+, Fragaria vesca, Crep. bien., Thym. Serp., Salix cin., S. Capr., S. aurit.

1226. A. florea *F.* 3 mm.—Sisymbr. off., Stell. med., Rubus frutic., Bryon. dioica ♀ and ♂ F+I+, B. alba ♀ and ♂ F+I+, Cirs. arv., Card. nut.

1227. A. florentina *Mg.*—Brass. Rapa, Bellis per.

1228. A. floricola *Ev.* (cf. No. 1282).—Brass. Rapa, Stell. med., Salix cin., S. Capr., S. aurit.

1229. A. fucata *Sm.*—Brass. Rapa, B. Nap., Rosa can., Rubus frutic., R. Id., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Coton. integ. ? F+I+, Bryonia alba, Aegop. Podagr., Heracl. Sphond., Anthrisc. sylv., Tarax. off., Crep. vir., Vacc. Myrt.

1230. A. fulva *Schr.* 3 mm.—Berb. vulg., Viola odor. F±I±, Polyg. Chamaeb., Trif. prat., Prunus dom., P. avium, P. Cer., P. spin., Crat. Oxyac., Cydonia jap., Pyrus Malus, Sorbus Auc., Ribes rubrum, R. Gross., Tarax. off., Vacc. uligin., Forsyth. virid., Scopolia atrop., Verbasc. phoenic., Nepeta Glech. F±I±, Dodecath. integrif., Euphorb. pal., E. pil., Salix cin., S. Capr., S. aurit., S. nigric., Tulipa sylv., Fritill. imper., F. latifol., Hyac. orient., Muscari botr., M. Lelievrii.

1231. A. fulvago *Chr.*—Polyg. com., Geran. pyren., Aegop. Podagr., Thrinc. hirt., Hypoch. radic., Tarax. off., Crep. bien., C. vir., C. palud., Hierac. Pilos., H. muror., Jas. mont.

1232. *A. fulvescens Sm.* (=A. humilis *Imh.*) ♂ 3½ mm. (cf. No. 1245).—Ranunc. auric., Brass. oler., Genista tinct. F+I+, Pimpin. Saxifr., Thrinc. hirt., Leont. hast., Hypoch. radic., H. glabra, Tarax. off., Crep. bien., Hierac. Pilos., H. vulgat., Jas. mont.

1233. *A. fulvicrus K.* (=A. flavipes *Pz.*, cf. No. 1223), 3–3½ mm.—Anem. nemor., Ranunc. acris, R. rep., R. bulb., Berb. vulg., Papaver Rhoeas, Brass. oler., Helianth. vulg., Stell. med., Malva sylv., Hyper. perfor., Geran. pal., Saroth. scop. F±I±, Genista tinct. F+I+, G. angel. F+I+, Medic. falc., Melilot. albus ♀ and ♂ F+I+, Trif. rep. ♀ F+I+, T. prat. ♀ F+I+, Prunus spin., Potent. verna, Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Philad. coron., Bryonia dioica ♀ F+I+, Carum Car., Heracl. Sphond., Tussil. Farf., Achill. Millef., A. Ptarm., Anthem. arv., Tanac. vulg., Senec. Jacob., Cirs. arv., Cichor. Int., Thrinc. hirt., Leont. aut., Tarax. off., Crep. tector., Campan. Trach., Jas. mont., Call. vulg., Echium vulg., Veron. Cham., Mentha aquat., Nepeta Glech., Polygon. Fagopyr., Salix cin., S. Capr., S. aurit., S. vimin., Cyprip. Calc. ♀ F+I+.

1234. A. fulvida *Schenck.*—Rubus Id., Hierac. Pilos., Euphorb. Cypar., Salix cin., S. Capr., S. aurit.

1235. *A. fumipennis Schmiedkn.* (2nd gen.) (=A. cineraria, cf. No. 1198).—Epil. angust., Cirs. arv.

1236. A. fuscipes *K.* (cf. No. 1281).—Trif. arv. ♂ F+I+, Achill. Millef., A. Ptarm., Senec. Jacob., Call. vulg.

1237. A. genevensis *Schmiedekn.*—Potent. verna.

1238. *A. gracilis Schenck.* (=A. argentata *Sm.*, cf. No. 1187).—Salix cin., S. Capr., S. aurit.
1239. A. gwynana *K.* (cf. Nos. 1240 and 1241) 2½ mm.—Clemat. recta, Pulsat. vulg. F+I+, Ranunc. acris, R. rep., R. bulbos., R. Fic., Cardam. prat., Brass. oler., B. Rapa, Lunar. ann. F+I±, Raphan. sat., Holost. umbell., Stell. Holost., S. med., Malva sylv., Geran. prat., G. dissect., G. molle., G. Robert., Erod. cicut., Prunus spin., Acer Pseudopl., Rubus frutic. F+I+, Potent. steril., Spir. salicif., Crat. Oxyac., Cydonia jap., Pyrus comm., Ribes alp., R. Gross., Chrysosplen. alt., Knaut. arv., Solid. Virgaur., Tussil. Farf., Petas. off., Bellis per., Cirs. arv., C. pal., Card. crisp., Tarax. off., Hierac. umbell., Campan. rot., C. Trach., C. persic., C. pat., Jas. mont., Vacc. Myrt., V. uligin., Erythr. Cent., Pulm. off., Atropa Bell., Verbasc. nigr., Linar. vulg., Veron. Cham., V. triph., V. Tournef., V. hederif., Prim. elat. F±I+, P. veris F±I+, P. vulg. F±I+, Salix aurit., S. Capr., S. cin., S. alba, S. fragil., S. purp., S. rep., Gagea fasc., G. arv., Scilla sibir.
1240. *A. gwynana K. var. aestiva Sm.* (2nd gen.) (=A. gwynana *K.*, cf. No. 1239).—Melilot. alb. F+I+, Valerian. olit.
1241. *A. gwynana K. var. bicolor F.* (2nd gen.) (=A. gwynana *K.*, cf. No. 1239).—Aneth. grav.
1242. A. hattorfiana *F.* 6–7 mm.—Libanot. mont., Dauc. Car., Knaut. arv., K. sylv., Scab. Columb., Jas. mont., Echium vulg.
1243. A. helvola *L.* (cf. No. 1309).—Berb. vulg., Prunus spin., Geum riv., Crat. Oxyac., Aegop. Podagr., Tarax. off., Jas. mont., Polyg. Fagop., Salix cin., S. Capr., S. aurit.
1244. *A. hirtipes Schenck.* (=A. curvungula *Thoms.*, cf. No. 1210).—Campan. glom., Phyteum nigr.
1245. A. humilis *Imh.* (cf. No. 1232).—Ranunc. acris, R. rep., R. bulb., Brass. oler., Crat. Oxyac., Hypoch. radic., Tarax. off., Crep. bien., Hierac. Pilos., H. umbell., Thym. dalm., Salix sp.
1246. A. hypopolia (Pér.) *Schmiedekn.*—Sisymbr. orient.
1247. A. julliani *Schmiedekn.*—Muscari comos., M. racemos.
1248. A. korleviciana *Friese.*—Trif. prat., Lysim. vulg.
1249. A. labialis *K.*—Res. lutea, Geran. molle, Trif. prat. ♀ F+I+, ♂ (F+I+), Lotus corn. ♀ F+I+, Onobr. viciif., Vic. Faba F±I+, Rosa can., Crat. Oxyac., Bryon. alba, Anthr. sylv., Viburn. opul., Tarax. off., Hierac. Pilos., Campan. pat., Asperug. proc., Echium vulg., Thym. Serp., T. dalm., Ajug. rept. ? F±I±, Allium rot.
1250. A. labiata *Schenck.* (cf. Nos. 1288 and 1291).—Nasturt. sylv., Stell. Holost., Lotus corn., Bryon. alba, Cornus sang., Tarax. off., Veron. Cham.
1251. A. lapponica *Zett.*—Tussil. Farf., Vacc. Myrt., Salix sp.
1252. A. lepida *Schenck.* (cf. No. 1215).—Conium macul., Achill. Millef., A. Ptarm.
1253. A. limbata *Ev.*—Sisymbr. orient., Dorycnium herbac., Melilot. altiss. F+I+, Sedum acre, Salv. off. F+I+, S. Bertol., Thym. Cham., T. dalm.
1254. A. lucens *Imh.*—Myagr. perfol., Melilot. altiss. F+I+, Trif. nigresc., Potent. hirta., Aneth. grav., Dauc. Car., Card. pycnoceph., Centaur. Jac., Thym. Cham., T. dalm., Salix cin.
1255. A. marginata *F.* (cf. No. 1195).—Knaut. arv., Succ. prat., Scab. Columb., Scab. suav., Onopord. Acanth., Leont. aut., Hierac. Pilos., Jas. mont.
1256. *A. minutula K.* (2nd gen.) (=A. parvula *K.*, cf. No. 1272).—Rubus frutic., Petrosel. sat., Carum Car., Peuced. Cerv., Inula Hel., Anthem. arv., Veron. Cham., V. Beccab., Salix sp.
1257. A. mitis (Pér.) *Schmiedekn.*—Acer Pseudoplat., Salix sp.
1258. *A. mixta Schenck.* (=A. varians *K.* var. mixta *Schenck.*, cf. No. 1310).—Tarax. off.
1259. A. morawitzi *Thoms.*—Tussil. Farf., Tarax. off., Campan. rot., Salix Capr., S. cin., S. alba, S. fragil., S. vimin., S. rep.
1260. A. morawitzi *Thoms.* var. paveli *Mocs.* (cf. No. 1273).—Salix Capr., S. cin.
1261. A. morio *Brull.*—Cheiranth. Cheiri, Symbr. orient., Myagr. perfol., Res. lutea, Cist. monspel., Saroth. scop., Dorycnium hirs., D. herbac., Melilot. altiss. F+I+, Prunus Mahaleb, Eric. arb., Thym. Cham., T. dalm., Teucr. Pol.
1262. A. nana *K.*—Nasturt. lippic., Arab. aren., Brass. oler., Sinap. arv., Bunias Erucago, Raphan. sat., Cist. vill., C. monspel., C. salviif., Tun. saxifr., Paliur. acul., Melilot. altiss. F+I+, Trif. prat., Potent. rept., P. verna,

Saxifr. umbrosa, Carum Carvi, Heracl. Sphond., Dauc. Car., Achill. Millef., A. Ptarm., Anthem. arv., Cirs. arv., Hypoch. radic., Conv. cantabr., Myosot. interm., Thym. dalm., Polygon. Fagop., Euphorb. Pepl.

1263. A. nasuta *Gir.*—Melilot. albus, Anchusa off.

1264. A. neglecta *Dours.*—Alyss. mont., Lam. purp., Salix purp.

1265. A. nigriceps *K.*—Hyper. perfor., Trif. rep. F+I+, T. arv. F+I+, Sedum acre, Succ. prat., Achill. Millef., A. Ptarm., Senec. Jacob., Cirs. arv., Campan. rot., Jas. mont., Call. vulg., Mentha sylv., Thym. Serp.

1266. A. nigroaenea *K.* 3–3½ mm.—Ranunc. acris, R. rep., R. Fic., Papaver nudicaule, Chelidon. majus, Arab. aren., Brass. oler., B. Rapa, B. Nap., Res. luteola, R. odor., Acer camp., Genista angl. F+I+, Onobr. viciif., Prunus avium, Rubus Id., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Pyrus comm., Sorbus Auc., Deutzia crenata, Bryon. dioica ♀ and ♂ F+I+, Ribes aur., R. Gross., Carum Carvi, Tussil. Farf., Anthem. arv., Chrys. Leuc., Tarax. off., Vacc. Myrt., V. uligin., Cynogloss. off., Thym. Serp., Lam. purp., Salix cin., S. Capr., S. aurit., S. rep., Cyprip. Calc. ♀ F+I+.

1267. A. nitida *Fourcr.* 3½ mm.—Adon. vern., Ranunc. acris, Papaver nudicaule, Chelidon. majus, Sisymbr. austriac., Alliar. off., Brass. Rapa, Coron. Fl.-cuc., Prunus spin., Crat. Oxyac., Sorbus Auc., Philad. coron., Ribes Gross., Aegopod. Podagr., Heracl. Sphond., Anthrisc. sylv., Asper. taur., Valerian. olit., Bellis per., Doronic. caucus., Centaur. nigresc., Tarax. off., Symph. off., Pulm. off., Veron. Cham., Lam. alb. F±I+, Ajug. rept. ? F±I±, Euphorb. pal., Salix cin., S. Capr., S. aurit., S. vimin.

1268. A. nobilis *Mor.*—Sisymbr. orient.

1269. A. nycthemera *Imh.*—Salix sp.

1270. A. ovina *Klg.* (cf. No. 1277).—Tarax. off., Salix cin., S. Capr., S. aurit., S. vimin.

1271. A. parviceps *Kriechb.*—Salix sp.

1272. A. parvula *K.* (cf. No. 1256).—Anem. nemor., Adon. vern., Ranunc. auric., R. lanugin., R. Fic., Papaver nudicaule, Nasturt. lippic., Arab. aren., A. alb., Cardam. prat., Brass. Rapa, B. Nap., Schiever. podol., Eroph. verna, Thlaspi arv., Lepid. sat., Caps. Bursa-past., Isat. tinctor., Myagr. perfol., Res. lutea, Helianth. vulg., Cist. salviif., Tun. Saxifr., Holost. umbell., Stell. Holost., S. med., Cerast. brachypet., Malva sylv., Geran. pyren., G. molle, Erod. cicut., Medic. lupul., Trif. nigresc., T. minus, Lotus corn., Coron. Emerus, Prunus Armen., P. spin., P. Padus, Rubus Id., Potent. sylv., P. verna, P. cinerea, P. opaca, Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Pyrus Malus, P. comm., Sedum acre, Ribes alp., R. rubrum, R. Gross., Chrysosplen. alt., Petrosel. sat., Aegop. Podagr., Carum Carvi, Pimpinella magn., P. Saxifr., Oenan. aquat., Aneth. grav., Heracl. Sphond., Tordyl. apul., Dauc. Car., Anthr. sylv., Chaeroph. tem., Valerianel. olit., Tussil. Farf., Bellis per., Solidag. Virgaur., Calend. arv., Leont. aut., Tarax. off., Crep. bien., Hierac. Pilos., Vacc. Myrt., Call. vulg., Myosot. interm., Verbasc. Thaps., Veron. Cham., V. Beccab., V. agr., V. hederif., Salv. Bertol., Thym. dalm., Nepeta Glech. F+I+, Ajug. genev., Salix cin., S. Capr., S. aurit., S. alba, S. fragil., Cyprip. Calc. F±I±, Gagea spath., Ornithog. refract., Scilla marit.

1273. *A. paveli Mocs.* (=A. morawitzi *Thoms.* var. paveli *Mocs.*, cf. No. 1260).—Salix sp.

1274. *A. pectoralis Pér.* (2nd gen.) (=A. thoracica *F.*, cf. No. 1303).—Veron. Spic.

1275. A. pilipes *F.* (=A. carbonaria *L.*, cf. No. 1194), 3 mm.—Melilot. altiss. F+I+, M. offic. F+I+, M. albus F+I+, Prunus avium, Potent. Anser., Sorbus Auc., Aegop. Podagr., Angel. sylv., Aneth. grav., Achill. Millef., A. Ptarm., Cirs. arv., Centaur. Jac., C. rhen., Tarax. off., Jas. mont., Vacc. uligin., Myosot. sylv., Verbasc. nigr., Mentha aquat., Nepeta Glech., Polygon. Fagop., Salix aurit., S. cin., S. Capr.

1276. A. polita *Sm.*—Hierac. Pilos.

1277. *A. pratensis Nyl.* (=Andrena ovina *Klg.*, cf. No. 1270).—Tarax. off., Salix rep., Cypriped. Calc. F+I+.

1278. A. praecox *Scop.* (cf. No. 1297).—Berb. vulg., Iber. amara, Viola odor., Sorbus Auc., Tussil. Farf., Tarax. off., Hierac. Pilos., Salix Capr., S. cin., S. aurit., S. alba, S. fragil., S. vimin.

1279. A. propinqua *Schenck.*—Sisymbr. austriac., Brass. oler., B. Rapa, B. Nap., Bunias orient., Melilot. albus F+I+, Coron. var. ♀ F+I+, Prunus Cer.,

Rosa can., Rubus frutic., Crat. Oxyac., Ribes Gross., Aneth. grav., Centaur. Scab., Leont. aut., Tarax. off., Hierac. staticefol., Campan. rot., Jas. mont., Salix alba, S. fragil., S. vimin., S. rep.

1280. A. proxima *K.* (cf. No. 1203).—Potent. Anser., Aegop. Podagr., Anthr. sylv., A. Ceref., Chaeroph. tem., Leont. hast., Tarax. off., Hierac. Pilos., Euphorb. Cypar.

1281. *A. pubescens K.* (=A. fuscipes *K.*, cf. No. 1236).—Call. vulg., Eric. tetr.

1282. *A. punctulata Schenck.* (=A. floricola *Ev.*, cf. No 1228).—Brass. Rapa.

1283. *A. rosae Pz.* (=A. austriaca *Pz.*, cf. No. 1189).—Ranunc. acris, R. rep., R. bulb., Caps. Bursa-past., Eryng. camp., Pimpin. magn., Heracl. Sphond., Salix sp.

1284. *A. ruficrus Nyl.* (=A. rufitarsis *Zett.*, cf. No. 1285).—Tussil. Farf., Salix cin., S. Capr., S. aurit.

1285. A. rufitarsis *Zett.* (cf. No. 1284).—Tussil. Farf., Tarax. off., Salix alba, S. fragil., S. triand.

1286. A. rufohispida *Dours.*—Asparag. off.

1287. A. rufula (Pér.) *Schmiedekn.*—Acer Pseudoplat., Salix sp.

1288. *A. schencki Mor.* (=A. labiata *Schenck.*, cf. Nos. 1250 and 1291).—Scab. Columb., Ajug. rept. F±I+.

1289. A. schlettereri *Friese.*—Cheiranth. Cheiri.

1290. A. schmiedeknechti (*Mg.*) *Schmiedekn.*—Rhamn. alatern.

1291. *A. schrankella Nyl.* (=A. labiata *Schenck.*, cf. Nos. 1250 and 1288) 4 mm.—Malva Alc., Trif. prat. ♀ F+I+, T. procumb. ♀ F+I+, Prunus spin., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Saxifr. gran., Imperat. Ostruth., Heracl. dissect., Achill. Millef., A. Ptarm., Anthem. arv., Chrys. Leuc., Onopord. Acanth., Salix cin., S. Capr., S. aurit.

1292. A. scita *Ev.*—Sisymbr. orient.

1293. A. sericata *Imh.*—Salix sp.

1294. A. shawella *K.* (cf. No. 1201).—Hyper. perfor., Potent. sylv., Chaeroph. tem., Leont. aut., L. hast., Campan. rot., C. Trach., Jas. mont.

1295. A. simillima *Sm.*—Call. vulg., Thym. Serp.

1296. A. sisymbrii *Friese.*—Sisymbr. orient.

1297. *A. smithella K.* (=A. praecox *Scop.*, cf. No. 1278) 2 mm.—Stell. med., Crat. Oxyac., Sorbus Auc., Ribes rubr., R. Gross., Valerian. olit., Tarax. off., Salix cin., S. Capr., S. aurit.

1298. A. spinigera *K.* (cf. No. 1217).—Lam. mac., Salix sp.

1299. A. suerinensis *Friese.*—Sisymbr. orient.

1300. *A. symphyti* (*Pér.*) *Schmiedekn.* (=A. angustior *K.*, cf. No. 1185).—Symph. tuber.

1301. A. taraxaci *Giv.*—Tordyl. apul., Tussil. Farf., Tarax. off., Salix sp.

1302. A. tarsata *Nyl.*—Potent. sylv., Leont. aut., Hypoch. radic., Jasion. mont.

1303. A. thoracica *F.* (cf. No. 1274).—Raphan. sat., Melilot. altiss. F+I+, Prunus spin., P. Mahaleb, Rubus frutic., Potent. hirta, Tussil. Farf., Bellis per., Tarax. off., Call. vulg., Anchusa panic., Echium vulg., Ajug. genev., Salix alba, S. fragil., S. rep.

1304. A. tibialis *K.* (=*A. atriceps K.*, cf. No. 1188).—Ranunc. acris, R. rep., R. bulb., Berb. vulg., Sisymbr. austriac., S. orient., Brass. Nap., Cytis. Lab. F+I+, Prunus dom., P. avium, Rubus frutic., Potent. sylv., Crat. Oxyac., Sorbus Auc., Philad. coron., Ribes Gross., Aneth. grav., Heracl. Sphond., Siler trilob., Chaeroph. hirs., Moloposp. Peloponnes., Viburn. Opul., Tussil. Farf., Tarax. off., Jas. mont., Lam. purp., Salix cin., S. Capr., S. aurit., S. alba, S. fragil.

1305. A. tridentata *K.*—Senec. Jacob.

1306. A. trimmerana *K.*—Ranunc. acris, R. rep., R. bulb., Berb. vulg., Brass. oler., Acer camp., A. Pseudoplat., Rubus frutic., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., C. monog., Philad. coron., Ribes sanguin., R. Gross., Aegop. Podagr., Tarax. off., Ajug. rept., Salix cin., S. Capr., S. aurit., S. alba, S. fragil.

1307. A. tscheki *Mor.* (=*A. nigrifrons Sm.*).—Alliar. off., Alyss. mont., Thlaspi praec., Salix sp., Muscari racemos.

1308. A. varians *K.*—Ranunc. Fic., Prunus spin., Rubus Id., Crat. Oxyac., Pyrus Malus, P. comm., Sorbus Auc., Ribes aur., R. Gross., Tussil. Farf., Tarax. off., Vacc. Myrt., Myosot. sylv., Polygon. Fagopyr., Salix cin., S. Capr., S. aurit., S. alba, S. fragil.

1309. A. varians *K.* var. helvola *L.* (=*A. helvola L.*, cf. No. 1243).—Prunus avium, Sorbus Auc., Ribes Gross., Salix sp.
1310. A. varians *K.* var. mixta *Schenck.* (cf. No. 1258).—Ribes Gross., Salix sp.
1311. A. ventralis *Imh.*—Tarax. off., Hierac. Pilos., Salix cin., S. Capr., S. aurit., S. amygd., S. rep.
1312. A. ventricosa *Dours.*—Erod. cicut.
1313. *A. xanthura Schmiedekn.* (=A. lathyri *Alfken.*) 3–5½ mm.—Genista tinct. F+I+, Cytis. Lab. F+I+, C. nigric., Medic. lupul., Trif. prat. ♀ F+I+, T. arv. ♀ F+I+, Lotus corn. ♀ F+I+, Vicia sep. F+I+, Lathyr. mont. ♀ and ♂ F+I+, Potent. verna, Chrys. Leuc., Hypoch. radic., Crep. vir., Hierac. Pilos., Veron. Cham., Salix alba, S. fragil.
1314. *A. zonalis K.* (=A. austriaca *Pz.*, cf. Nos. 1189 and 1283).—Crepis bien.
1315. A. sp.—Aquileg. atrata, Corydal. cava F±I+, Trif. rep. F+I+, Vit. vinif., Geran. sylv., Crat. Oxyac., Ribes Gross., Saxifr. oppositif., Crucian. angust., Valer. asarif., Bidens trip., Tragop. prat., Lobel. erin., Echinosp. Lapp., Myosot. vers., Salv. prat. F±I+, Origan. vulg., Plantag. med., Euphorb. dendroid., Salix amygd., Listera ov. F+I+, Gladiol. seget., Tamus comm.
1316. Anthidium cingulatum *Ltr.*—Onobr. viciif.
1317. A. diadema *Ltr.*—Res. lutea, Paliur. acul., Marrub. candidiss., Teucr. Cham., T. flav.
1318. A. florentinum *F.*—Teucr. Cham.
1319. A. interruptum *F.*—Anchusa off.
1320. A. laterale *Ltr.*—Centaur. aren.
1321. A. lituratum *Pz.*—Sedum refl., S. album.
1322. A. manicatum *L.* 9–10 mm.—Delphin. Consol., Geran. Robert., Lupin. polyph., Ononis spin. ♀ and ♂ F+I+, O. rep., Medic. Sat. ♀ and ♂ F+I+, Trif. prat. ♀ and ♂ F+I+, Lotus corn. ♀ F+I+, Coron. var. ♀ F+I+, Onobr. viciif., O. mont., Vicia Cracca ♀ F+I+, V. villosa var. varia, Pisum sat. ♀ F+I+, Lathyr. odor., Glycine chin. ♂ F+I+, Semperviv. mont., Inula Hel., I. brit., Centaur. nigr., C. Scab., C. aren., Symph. off., S. peregr., Echium vulg., Antirrh. maj. F+I+, Linar. vulg. F+I+, Digit. purp., Lavand. vera, Salv. prat. ♀ and ♂ F+I+, S. prat. var. varieg. ♂ F+I+, S. off. ♀ F+I+, S. verben., S. Bertol., S. Baumg., S. lanata, Thym. Cham., Calam. Acin., C. alpina, Clinop. vulg., Nepeta Muss. ♀ and ♂ F+I+, N. melissif., N. macr. ♀ F+I+, N. granat., Lam. alb. ♀ and ♂ F+I+, L. purp. F+I+, L. gargan., L. flexuos., Stach. sylv. ♀ and ♂ F+I+, S. pal. F+I+, S. recta ♀ and ♂ F+I+, S. ital., S. germ. ♀ and ♂ F+I+, S. germ. var. villosa F+I+, S. cretica, S. lanata, S. longispic., S. ramosiss., S. setif., S. Beton. ♀ and ♂ F+I+, S. grandifl., S. Alopecur., S. hirsut., S. densif., Phlom. tuber. F+I+, P. armen., Siderit. scordioid., Marrub. vulg. F+I+, M. propinqu., Ball. nigr. ♀ and ♂ F+I+, Leon. lanat., Scutell. galer. F+I+, S. hastif., Prun. grandifl., Ajug. Chamaepyt., Teucr. Scorod. F+I+, T. Botrys, T. canum.
1323. A. montanum *Mor.*—Lotus corn. F+I+.
1324. A. oblongatum *Ltr.*—Res. lutea, R. odor., Ononis rep., Lotus corn. ♀ and ♂ F+I+, Sedum acre, S. refl., Centaur. nigresc., Borago off. ♀ and ♂ F+I+, Echium vulg., Ajug. Chamaepyt.
1325. A. punctatum *Ltr.*—Res. odor., Genista tinct. (F+I+), Ononis spin. ♀ and ♂ F+I+, Lotus corn. ♀ and ♂ F+I+, Sedum refl., Cichor. Int., Thym. Serp., Nepeta nuda, Ball. nigr. ♂ F+I+, Teucr. Botrys.
1326. A. septemdentatum *Ltr.*—Card. pycnoceph., Salv. Bertol., Origan. vulg., Thym. Cham., T. dalm., Calam. Acin., Stach. recta F+I+, Marrub. candidiss., Ball. nigr. F+I+, Ajug. genev.
1327. A. septemspinosum *Lep.*—Centaur. aren.
1328. A. strigatum *Panz.*—Res. odor., Dorycnium herbac., Melilot. altiss. F+I+, M. off. F+I+, Lotus corn. ♀ and ♂ F+I+, Centaur. Jac., Leont. hast., Jas. mont., Phlox pan., Prun. vulg., Verben. off.
1329. A. variegatum *F.*—Paliur. acul., Anchus. off., Clinop. vulg., Teucr. Cham.
1330. A. sp.—Pentstem. campan., Ocymum.
1331. *Anthophora acervorum L.* (=Podalirius acervorum *L.*, cf. Nos. 1339 and 1777).—Prim. vulg.
1332. *A. aestivalis Pz.* (=Podalirius retusus *L.*, cf. No. 1795).—Coryd. lutea, Acer Pseudoplat., Trif. prat. F+I+, Vicia sep. ♂ F+I+, Prunus avium, Anchus. off., Lycium vulg., Melamp. arv., Salv. prat. ♂ F+I+, S. off. ♀ F+I+,

Nepeta Glech. ♂ F+I+, Lam. mac. ♀ and ♂ F+I+, Ball. nigr. F+I+, Ajug. rept. F+I+, Scilla marit.

1333. *A. femorata Oliv.* (=Podalirius femoratus *Oliv.*, cf. No. 1785).—Cerinthe maj., Muscari comos.

1334. *A. furcata Pz.* (=Podalirius furcatus *Panz.*, cf. No. 1787).—Knaut. arv., Echium vulg., Atropa Bell., Salv. verticill. ♀ F+I+, Nepeta melissif., Stach. sylv. ♀ and ♂ F+I+, Ball. nigr. ♀ and ♂ F+I+, Prun. vulg. F+I+.

1335. *A. haworthana K.* (=Podalirius retusus *L.*, cf. No. 1795).—Veron. mont., Melamp. arv., Scilla marit.

1336. *A. nidulans F.* (=Podalirius quadrifasciatus *Vill.*, cf. No. 1792).—Echium vulg.

1337. *A. parietina F.* (=Podalirius parietinus *F.*, cf. No. 1790).—Trif. pannon., Nepeta Muss. ♀ and ♂ F+I+, N. melissif., N. Glech. ♂ F+I+.

1338. *A. personata* (*Ill.*) *Er.* (=Podalirius fulvitarsis *Brullé*, cf. No. 1786).—Delphin. elatum, Glycine chin. ♀ and ♂ F+I+, Symph. off., Salv. prat. ♀ and ♂ F+I+, Lam. alb. ♀ and ♂ F+I+, L. Galeobd. ♀ F+I+.

1339. *A. pilipes F.* (=Podalirius acervorum *L.*, cf. Nos. 1331 and 1777) 19–21 mm.—Hellebor. foetid. F+I+, Delphin. elat., Chelidon. maj., Diclyt. spect. F+I+, Coryd. cava ♀ and ♂ F+I+, C. solida F+I+, C. bract., C. Kolpakowsk., Cheiranth. Cheiri, Lunar. ann. ♂ F+I+, Viola odor. ♂ F+I+, V. canina ♀ F+I+, V. tric. vulg. F+I+, V. tric. arv. ♂ F+I+, Polyg. Chamaeb., Trif. prat. F+I+, Coron. Emer., Vicia sep. ♀ and ♂ F+I+, Lathyr. mont. ♀ F+I+, Crat. Oxyac., Cydon. jap., Pyrus Malus, Ribes aur., Bergenia subcil., Syring. vulg., Symph. off., S. tuber., S. grandiflor., S. caucas., S. peregr., Pulm. off., Cerinthe maj., Lithosp. purp.-coer., Mertensia pulmonar., Salv. prat. ♀ and ♂ F+I+, Nepeta Muss. ♀ F+I+, N. Glech. ♀ and ♂ F+I+, Lam. alb. ♀ and ♂ F+I+, L. mac. ♀ and ♂ F+I+, L. purp. ♀ and ♂, L. amplex. ♀ and ♂ F+I+, L. incis. ♀ and ♂ F+I+, L. gargan., Ajug. rept. F+I+, Prim. elat. F+I+, P. veris F+I+, P. veris var. color., P. vulg. F+I+, Daphne Mez., Croc. varieg., Pancrat. marit., Narc. Pseud.-Narc. F+I+, N. odor., N. polyanth., N. Tazetta, Fritill. imper., Ornithog. affine, Hyac. orient., Muscari comos.

1340. *A. quadrimaculata F.* (=Podalirius vulpinus *Panz.*, cf. No. 1801) 9–10 mm.—Malva rotundif., Trif. rep. ♀ F+I+, T. fragil. ♀ F+I+, Lotus corn. ♀ F+I+ Cirs. arv., Anchus. off., Echium vulg., Lycium vulg., Lavand. vera, Nepeta nuda, N. Muss. ♀ F+I+, N. melissif., N. macr. ♀ F+I+, N. granat., Lam. purp. ♀ and ♂, Stach. sylv. ♀ and ♂ F+I+, S. pal. ♀ and ♂ F+I+, Ball. nigr. ♀ and ♂ F+I+, Teucr. Scorod. F+I+, T. canum.

1341. *A. retusa L.* (=Podalirius retusus *L.*, cf. No. 1795) 16–17 mm.—Trif. rub., Veron. mont., Pedic. sylv.

1342. *A. sp.* (=Podalirius sp.)—Lathyr. sylv. F+I+, Digit. ambigua, Lam. alb., Teucr. Cham.

1343. * Apis mellifica L. (=*A. mellifera L.*) ☿ 6 mm.—Clemat. Vit., C. recta, C. Vitic., Thalictr. aquilegif., T. flav., Hepat. tril., H. angul., Pulsat. vulg. F+I+, P. prat. F+I+, Anem. sylv., A. nemor., A. ranunculoid., Adon. vern., A. aestiv., A. autumn., Batrach. aquat., Ranunc. Flamm., R. acris, R. rep., R. bulb., R. auric., R. lanugin., R. Fic., Caltha pal., Eranthis hiemalis F+I+, Hellebor. foetid. F+I+, H. virid. F+I+, H. niger. F+I+, H. atrorub., H. cyclophyll., Nigella arv. F+I+, N. damasc. F+I+, N. sativa F+I+, Aquileg. vulg. F+I+, F±I+, Delphin. Consol. F±I±, D. Ajacis F±I±, Berb. vulg., Epimed. alp. F+I+, Nymph. alba, Papaver Rhoeas, P. somnif., P. bracteat., Glaucium flav., Chelid. maj., Sanguin. canad., Diclyt. spectab. F±I+, Coryd. cava F+I+, C. solida F±I+ C. capnoides F+I+, C. clavic., Fumar. off. F+I+, Cheiranth. Cheiri, Nasturt. off., N. amphib., N. sylv., Barb. vulg., Arab. alp., A. paucifl., A. aren., A. alpest, A. albida, Cardam. prat., Hesper. matron., Sisymbr. austriac., S. strictiss., Stenophrag. Thalian., Alliar. off., Brass. oler., B. Rapa, Sinap. arv., S. alba, Aubret. Column., A. spathulata. Lunaria annua F+I+, L. rediv., Schiever. podol., Eroph. verna, Cochlear. off., Thlaspi arv., Caps. Bursa-past., Isat. tinctor., Cak. marit., Crambe marit. F+I+, C. pinnatif., Raphan. Raph., R. sat., Res. luteola, R. lutea, R. odor., Helianth. vulg., Viola odor. F+I+, V. tric. vulg. F+I+, V. tric. arv. F+I+, Polyg. vulg., P. Chamaeb., Sapon. off., Coron. Fl.-cuc., Melandr. rubr., Sperg. arv., Aren. graminif., Stellar. Holost., S. med., Cerast.

semidec., Malva sylv., M. rotundif., M. negl., M. Alc., M. mosch., Lavat. thuring., Althaea rosea, A. off., A. cannab., Malope grandifl., Tilia ulmif., Hyper. perfor., H. quadrang., H. commutat., H. tetrapt., H. pulchrum, Acer platan., A. camp., A. pseudoplat., A. dasycarp., Aesc. Hippocast. (F+I+), A. Pavia, A. macrostach., Ampel. quinquef., Vit. vinif., V. ripar., Linum usitat., Geran. pal., G. sylv., G. prat., G. sanguin., G. pyren., G. phaeum, G. molle, G. Arnottian., G. iber., G. iber. var. platypetal., G. pseudosibir., G. reflex., G. striatum, Erod. cicut., Oxalis Acetos., O. stricta, Tropaeol. majus F±I±, F+I±, Impat. Balsam., I. glandulif. F+I+, Ruta graveol., Dictamn. albus, Ptelea trifol., Rhamn. Frang., Rhus Cotinus, R. typhina, Cercis Siliquastr., Saroth. scop. F+I+, Genista tinct. F+I+, G. angl. F+I+, G. pilosa F+I+, Ulex europ. F+I+, Cytis. Lab. F+I+, Lupin. lut. F+I+, L. angustif. F+I+, L. polyph., Ononis spin. F+I+, O. arv., Medic. sat. F±I+, M. falc., M. sylv., M. lupul. F+I+, Melilot. altiss. F+I+, M. albus F+I+, M. caerul. F+I+, Trif. rep. F+I+, T. rep. var. atropurpur. F+I+, T. hybr. F+I+, T. fragif. F+I+, T. mont. F+I+, T. prat. F±I+, F+I+, T. med., T. arv. F+I+, T. pallesc., T. agrar. F+I+, T. camp. F+I+, T. procumb. F+I+, Anthyll. mont., Lotus corn. F+I+, L. uligin. F+I+, Amorpha frutic., Colutea arboresc. F+I+ and F±I+, Glycyrrhiza grandifl., Robinia Pseudacacia F+I+, R. viscosa, Oxytropis pil., Astrag. glycyph. F+I+, Coron. var. F+I+, Ornithopus sat. ? F±I+, Hippocrep. com., Hedys. obsc., Onobr. viciif., Vicia Cracca F+I+, V. dumet., V. sep. F±I+, V. Faba F±I+, F+I+, V. hirs. F+I+, V. tetrasp., Lens escul., Lathyr. prat. F+I+, L. sat. F+I+, L. sylv. F+I+ and F±I+, L. tuberosus F+I+, L. latif., Glycine chin. F+I+, Phaseol. multiflor. F±I+, Persica vulg., Prunus dom., P. avium, P. Cer., P. spin., Rosa can., R. rubigin., Rubus frutic., R. caes., R. Id., R. spectab., R. serp., Geum riv., G. inclin., Fragaria vesca, Comar., pal., Potent. Anser., P. verna, P. caulesc., P. frutic., P. rup., P. Delphinensis, P. Kurdica, P. chrysantha, Agrim. Eupat., A. odor., Ulmar. pentap., U. Filip., Spir. sorbif., S. salicif., S. ulmif., S. digit., Crat. Oxyac., C. monog., Cydonia jap., Pyrus Malus, P. comm., Sorbus Auc., S. scand., Epil. angust., E. Dodon., E. hirs., E. parvifl., Oenoth. bien. F+I+, O. grandifl., Gaura bien., Lythr. Sal. F+I+, L. Sal. var. angustif., L. hyssopif., Philad. coron., Deutzia crenata, Bryonia dioica (F+I+), Sicyos angul., Cucumis sat., Cucurbita Pepo, Sedum Teleph., Ribes nigrum, R. rubrum, R. sanguin., R. Gross., Saxifr. umbrosa, S. (Bergenia) crassif., Bergenia subcil., Heuch. cylind., Tellima grandifl., Astrant. maj., Eryng. marit., E. camp., E. planum, Conium macul., Petrosel. sat., Aegop. Podagr., Sium latif., Levist. off., Angel. sylv., Archang. off., Tommas. vertic., Aneth. grav., Heracl. Sphond., H. sibir., H. pubesc., Siler trilob., Dauc. Car., Anthr. sylv., A. Ceref., Chaeroph. tem., C. hirs., Moloposp. Peloponnes., Cornus mas., Ebul. humile, Symphoric. racem. F+I+, Lonic. tatar., L. Xylost. (F+I+), L. nigra, L. iber., Asper. odor., A. styl., Valer. off., V. off. var. altiss., Ceph. rad., Knaut. arv., Succ. prat., Scab. Columb., S. ochrol., S. Dallap., S. dauc., S. atrop., Eupat. can., E. purp., Vernon. fascic., V. praeal., Tussil. Farf., Petas. off., Aster Tripol., A. Novae-Angliae, A. abbrev., A. conc., A. panicul. var. pubesc., A. sagitt., A. sparsifl., Galatel. hyssopif., Bellis per., Diplopap. amygd., Solidag. Virgaur., S. fragr., Dahlia variab., Silphium Asteris., S. erythroc., S. trifol., Helen. autumn., H. decur., Bidens cern., Bolton. glastif., Helianth. an., H. atror., H. decapet., H. divar., H. maximil., Rudb. lacin., R. specios., Anthem. arv., A. tinct., Matric. Cham., Tanac. vulg., T. macroph., Chrys. Leuc., Doronic. caucas., Cacal. hast., Senec. nemor., S. sarrac., S. macroph., S. Jacob., Calend. off., Echinops sphaeroc., E. bannat., E. exalt., Cirs. arv., C. lanceol., C. pal., C. heteroph., C. olerac., Card. crisp., C. Person., C. nut., Lappa min., L. toment., L. maj., Carl. acaul., Saussur. albesc., Centaur. Jac., C. nigr., C. mont., C. axill., C. Cyan., C. Scab., C. dealb., C. Fisch., C. orient., Cichor. Int., Leont. aut., L. hast., Helminth. echioid., Hypoch. rad., Tarax. off., Prenanth. purp., Mulged. alpin., Sonchus arv., Crep. bien., Hierac. Pilos., H. umbell., H. austr., H. brevifol., H. bupleur., H. crinit., H. pulmonarioid., H. viros., Lobel. Erin., Campan. rot., C. Scheuchz., C. rapunculoides, C. Trach., C. Erinus, C. Rapunculus, C. glom., C. latif., C. carpath., Hedraeanth. tenuif., Phyteum. spic., Jas. mont., Vacc. Myrt., V. uligin., V. Vit.-Id., Call. vulg., Eric. Tetr.,

Rhodod. praec., Kalmia polif., Ilex aquif., Ligustr. vulg., Syring. vulg., Forsyth. virid., F. susp., Asclep. syr. F+I+, Vinca min., Limnanth. vulg., Gent. Pneum., G. germ., Phacel. tanacetif., Hydroph. virgin., Polemon. coerul., Phlox rept., P. Subul., Conv. arv., Heliotrop. peruv., Cynogloss. off., C. column., Borago off., Anchusa off., A. Semperv., A. ochrol., Symph. off., S. tuber., S. grandifl., S. asperr., Pulm. off., P. angustif., P. angustif. × P. off., P. mont., Cerinthe min., Echium vulg., Caryolopha semperv., Lithosp. arv., Myosot. sylv., M. alpestr., M. interm., Lycium vulg., Solan. Dulc., S. nigr., Nicrandra physal., Atropa Bell., Nicot. Tab. F+I+, Physochlaena orient., Verbasc. Thaps., V. phoenic., Scroph. nod. F+I+, S. aquat., S. umbr., S. Scopol., S. orient., Antirrh. maj., A. Oront., Linar. vulg., L. striata, L. Cymb., L. genistif., L. purp., Pentstem. campan., P. pubesc., P. orat., P. procer., Veron. Cham., V. mont., V. Beccab., V. longif., V. spic., V. triph., V. agr., V. hederif., Melamp. prat., M. nemor., Pedic. sylv., P. rostr., Rhinan. maj., Euphras. Odont., E. off., Orobanche specios., Ocymum, Plectranth. glaucocalyx, Lavand. vera, Mentha arv., M. piper., M. aquat., M. sylv., Salv. prat. var. varieg. F±I±, Salv. sylv. F+I+, S. sylv. var. nemor. F+I+, S. virgat., S. off. F+I+, S. verticill. F+I+, S. Verben., Monarda did., M. did. var. mollis, Origan. vulg., O. maj., Satureia hort., Thym. Serp., T. vulg., Calam. Acinos, C. alpina, C. off., C. Nepeta, Melissa off. F+I+, Hyssop. off., Nepeta nuda, N. Muss. F+I+, N. Glech. ♀ flowers F+I+, ☿ flowers F+I+, and F±I+, Lophanth. rug., Lam. alb. F±I+, L. mac. F±I+, L. purp. F+I+ and F±I+, L. amplexic. F+I+, L. incis., L. Orvala, L. gargan., L. flexuos., L. Galeobd. F±I+ and (F+I+), Galeops. Tetr., Stach. sylv. F+I+, S. pal. F+I+, S. arv. F+I+, S. recta F+I+, S. germ. F+I+, S. grandifl., Siderit. hyssopif., Marrub. vulg. F+I+, M. peregr., Ball. nigr. F+I+, Leon. Card., L. Marrub., L. lanat., Prun. vulg. F+I+, Ajug. rept., Teucr. Scorod. F+I+, T. mont., T. Scord., Blephil. hirs., Verben. off., Lysim. Numm., Prim. elat. †, P. vulg. F+I+, Hottonia pal. F+I+, Cyclam. repand., C. iberic., Armer. elong., Plantag. lanc., P. med., Rumex Acetosa, Polygon. Fagop., P. Bistorta, P. amph., P. Convolv., Daphne Mez., D. Laureola, Laur. nob., Elaeagn. angustif., Thesium prat., Viscum alb. F±I±, Buxus semp., Euphorb. pal., E. Esula, E. virgat., E. amygdaloid., Mercur. perenn., Ulmus mont., U. camp., Castan. vesca, Coryl. Avell, Salix cin., S. Capr., S. aurit., S. triand., S. fragil., S. nigric., S. rep., S. cin. × S. purp. ♀, S. cin. × S. nigric. ♀, S. Capr. × S. siles. ♂, S. retusa, Popul. pyram., P. trem., Hydroch. Mors. ran., Commel. tuber., Orchis latif. F+I+, O. Morio F+I+, Epipact. pal. F+I+, Stanhop. tigr., Thalia dealb., Croc. vern., Gladiol. seget., G. triphyll., Iris Pseudac. F±I±, F±I+, I. pyren., I. gramin., Leucoj. vern., L. aest., Galanth. niv., Tamus comm., Tulipa Ocul.-sol., T. Gesn., Gagea fascic., G. arv., Fritill. imper., Lilium candid., Erythron. denscanis, Eremur. spect., Antheric. ramos., A. Liliago, Ornithog. umb., O. affine, O. pyren., Scilla sibir., S. amoena, S. cernua, S. campan., S. ital., S. tricol., Allium ursin., A. fallax, A. Porr., A. rot., A. carin., A. Cepa, A. fistul., Hyac. orient., H. candic., Muscari botr., M. racemos., M. pallens, Narth. ossifr., Asparag. off., A. amar., Camassia Fraseri.

1344. Biastes brevicornis *Pz.*—Conv. arv., Echium vulg.

1345. B. emarginatus *Schenck.*—Thym. Serp., Ball. nigr.

1346. B. truncatus *Nyl.*—Thym. Serp.

1347. * Bombus agrorum *F.*, ♀ 13–15 mm., ☿ 12–13 mm., ♂ 10–11 mm.—Ranunc. acris, R. rep., R. bulb., R. Fic., Aquileg. vulg., Delphin. elatum, Aconit. Nap., A. varieg. F+I+, Epimed. rubr., Chelidon. majus, Corydal. lutea, C. clavic., Brass. oler., Raphan. Raph., Helianth. vulg., Viola sylv., V. Rivin., V. can., V. tric. arv. F+I+, Polyg. Chamaeb., Thym. serpyll, Sil. infl., S. acaul., Coron. Fl.-cuc., Malva sylv., M. rotundif., Althaea rosea, Tilia ulmif., Hyper. perfor., H. quadrang., Aesc. Pavia, Geran. Robert., Impat. grandulif., Dictamnus albus, Rhamn. Frang., Saroth. scop. F+I+. Genista angl., Cytis Lab. ♀ F+I+, C. austr., Lupin. lut. ☿ F+I+, L. angustif. ☿ F+I+, Ononis rep., Medic. sat. ♀ and ☿ F+I+, M. falc., M. lupul. F+I+, Trif. rep. ☿ F+I+, T. hybr. F+I+, T. prat. ♀, ☿, and ♂ F+I+, T. incarn. F+I+, T. med., T. rub., T. arv. ☿ F+I+, Anthyllis Vuln. ☿ F+I+, A. Vuln. var. marit. ♀ F+I+, Lotus corn. ♀, ☿ and ♂ F+I+ L. uligin. F+I+, Robinia Pseudac. F+I+, Astrag. glycyph. ♀ F+I+,

A. Cicer., A. dan., A. exscapus, A. monspess., A. glycyphyl., Coron. var. ☿ F+I+, Ornithop. perpus. ? F±I+, Hedys. sibir., Onobr. viciif., Vicia Cracca ♀ and ☿ F+I+, V. dumet., V. sep. ♀ and ☿ F+I+, V. sat. ♂ F+I+, V. angustif. ☿ F+I+, V. Faba ☿ F+I+, V. Orobus, V. onobrychoid., Lathyr. prat. ♀ F+I+, L. marit. ♀ F+I+, L. sylvest. ♀ F+I+, L. heterophyll. F+I+, L. pal. F+I+, L. latif., L. mont. ♀, L. niger ♀ F+I+, L. brachypt., L. cirrhosus, L. incurvus, L. rotundif., Orobus aureus, O. hirs., Prunus Cer., Rubus frutic., R. caes., R. Id., R. spectab., Gerum. riv., Spir. sorbif., S. salicif., S. ulmif., Cydonia jap., Pyrus Malus, P. comm., Sorbus Auc., Epil. angust., E. hirs., Oenoth. bien. F+I+, O. Lamarck., Lythrum Sal. ♀, ☿ and ♂ F+I+, L. Sal. var. angustif. ♂ F+I+, Philad. coron., Sedum Teleph., Ribes Gross., Heracl. Sphond., Weigel. ros., Symphoric. racem. ☿ F+I+, Lonic. Pericl. F+I+, Lonic. Xylost. ☿ F+I+, Sherard. arvens., Asperul. cynanch., Dipsac. sylv., Cephal. ural., Knaut. arv., Succ. prat., Scab. Colomb., S. lucida, Tussil. Farf., Aster Tripol., Solidag. Virgaur., Dahlia variab., Helianth. an., Cacal. hast., Senec. Jacob., Cirs. arv., C. lanceol., C. pal., C. heteroph., C. olerac., Card. crisp., C. acanth., Onopord. Acanth., Lappa min., L. toment., Carl. acaul., Serrat. tinct., S. quinquef., Centaur. Jac., C. nigr., C. Cyan., C. Scab., Thrinc. hirt., Leont. aut., Picr. hierac., Tragop. prat., Tarax. off., Hierac. australe, Campan. rot., C. bonon., Phyteum. spic., Jas. mont., Vacc. Myrt., V. uligin., Arctostaph. Uva-ursi, Call. vulg., Erica Tetr., E. cin., Hypopit. multif., Asclep. syr. ♂ F+I+, Vinca min., V. maj., Limnanth. nymph., Gent. pneum., Conv. sep., C. Soldan., Anchus. off., A. ochrol., Lycops. arv., Symph. off., S. peregrin., Pulm. off., Cerinthe min., Echium vulg., E. rosul., Lithosp. arv., Myosot. vers., Lycium vulg., Solan. Dulc., S. nigr., Atropa Bell., Hyosc. nig., Verbasc. thapsif., V. Thaps., V. nigr., V. phoenic., Scroph. nod. ♀ and ☿ F+I+, Antirrh. maj., Linar. vulg., L. striata, L. purp., Digit. purp., Veron. agr., Melamp. prat., M. nemor., Pedic. sylv., P. palustr., Rhinanth. min., Euphras. odont., E. off., E. lutea, Lathr. Squam., Mentha aquat., Salv. prat. ♀ and ☿ F+I+, S. glutin. ♀ F+I+, S. off. ☿ F+I+, S. Bertol., S. lanata, Monarda var. purpur. F+I+, Thym. Serp., T. Cham., Calam. alpina, C. Nepeta, C. umbr., Clinop. vulg., Melissa off. ♂ F+I+, Rosmar. off., Nepet. Cat. ☿ F+I+, N. nuda, N. lophantha, N. Glech. ♀ and ☿ F+I+, Dracoceph. mold., Lophanth. rug., L. anisat., L. scroph., Lam. alb. ♀ and ☿ F+I+, L. mac. ♀ F+I+, L. purp. ♀ F+I+, L. amplexic. ♀ F+I+, L. Galeobd. ♀ F+I+, Molucella laev. ♂ F+I+, Galeops. sp. ?, G. Tetr. ♀ and ☿ F+I+, G. Ochr. ♀ F+I+, G. Ladan. F+I+, G. versic. F+I+, Stach. sylv. F+I+, S. pal. F+I+, S. recta ♀ F+I+, S. germ. ☿ F+I+, S. longispic., Beton. off. ♀ and ☿ F+I+, Phlom. tuber. ☿ F+I+, P. Kashm., Physostegia virgin., Ball. nigr. ♀, ☿ and ♂ F+I+, Leon. Card., L. Card. var. villos., L. lanat., Prun. vulg. F+I+, Ajug. rept. F+I+, A. pyram., Teucr. Scorod., T. Cham. F+I+, T. canum, Verben. off., Prim. elat. F+I+, P. veris F+I+, Armer. elong., Salix aurit., S. vimin., Commel. tuber., Orchis latif. F+I+, O. masc. F+I+, O. Morio F+I+, O. macul. F+I+, Listera ov. F±I+, Iris Pseudac. F+I+, ¦Polygonat. multifl.

1348. B. agrorum *F.* var. arcticus *Acerbi.*—Salix nigric., S. glauca, S. lapp., S. phyllicif.

1349. B. agrorum *F.* var. tricuspis *Schmiedekn.*—Melamp. prat.

1350. B. alpinus *L.*—Trif. rep. F+I+, Astrag. alp., Lathyr. marit. ♀, ☿ and ♂ F+I+, Rubus Chamaem., Tarax. off., Phyteum. Scheuchz., Vacc. uligin., Rhodod. hirs., Pedic. lappon., Salix nigric., S. glauca, S. lapp., S. phyllicif.

1351. B. alticola *Kriechb.* ♀ 11–13 mm., ☿ 9–12 mm., ♂ 8 mm.—Pulsat. alp. F+I+, Aconit. Napell. F±I+, F+I+, A. Lycoct., Trif. rub., T. alpin., Astrag. alp., Arnic. mont., Senec. cord., Cirs. spinos., Vacc. uligin., Call. vulg., Cerinthe alp., Linar. vulg., Veron. spic., Pedic. palustr., P. verticill., Barts. alp., Stach. sylv. ☿ F+I+, Soldan. pusilla.

1352. B. arenicola *Thoms.*—Viola can., Malv. sylv., Ononis spin. ♀ F+I+, Trif. rep. ☿ F+I+, T. prat. ♀ and ☿ F+I+, Lotus corn. ☿ F+I+, Vicia Cracca ♀ and ☿ F+I+, V. sep. ♀ F+I+, Lathyr. prat. ☿ F+I+, Epil. angust., Dipsac. sylv., Knaut. arv., Succis. prat., Cirs. arv., C. olerac., Card. nut., Thrinc. hirt., Tarax. off., Call. vulg., Symph. off., Echium vulg., Rhinanth. maj., Euphras. Odont., Thym. Serp., Lam. alb. ♀ F+I+, Galeops. Tetr.

♀ and ☿ F+I+, G. ochr. ♀ F+I+, Stach. sylv. ♀ and ☿ F+I+, Prun. vulg. F+I+, Ajug. rept. F+I+, Teucr. Scorod. ♀ F+I+.

1353. *B. argillaceus Scop.* (=var. of B. hortorum *L.*, cf. Nos. 1365 and 1392).—Cheiranth. Cheiri, Dorycnium hirs., Prunus Mahaleb. Cydonia jap., Lonic. etrusca, Arbut. Uned., Vinca maj., Veron. spic., Salv. prat. F+I+, S. glutin. F+I+, S. off. F+I+, S. clandest., S. Bertol., Satureia mont., Lam. alb. ♀ F+I+, L. mac. F+I+, Galeops. Tetr. ♀ and ☿ F+I+, G. Ladan. F+I+, Marrub. vulg. F+I+, M. candidiss., Gladiol. comm.

1354. *B. autumnalis Schenck* (=B. terrester *L.* var. autumnalis *F.*).—Beton. off.

1355. *B. brevigena Thoms.* (=B. mastrucatus *Gerst.*, cf. No. 1376).—Aconit. Nap. F±I+.

1356. *B. cognatus Steph.* (=B. muscorum *F.*, cf. No. 1381).—Viola tric. vulg. F+I+, Genista tinct. F+I+, Lupin. lut. ☿ F+I+, L. angustif., Trif. rep. F+I+, Lotus corn. ♀, ☿ and ♂ F+I+, Vicia angustif. F+I+, V. Faba ♀ F+I+, Oenoth. bien. × O. muric., O. Lamarck., Lythr. Sal. F+I+, Dipsac. Sylv., Senec. Jacob., Cirs. arv., C. lanceol., Call. vulg., Eric. Tetr., Gent. pneum., Anchusa off., Echium vulg., Lycium vulg., Rhinanth. maj., Ball. nigr. F+I+, Ajug. rept. F+I+, Teucr. canum.

1357. B. confusus *Schenck* 12–14 mm.—Coryd. lutea, Trif. prat. ♀ and ☿ F+I+, Astrag. Onobr., Onobr. viciif., Vicia sep., V. Faba ☿ F+I+, Geum riv., Epil. angust., Solidag. Virgaur., Heliops. pat., Card. crisp., Carl. acaul., Centaur. Scab., Thrinc. hirt., Tarax. off., Prenanth. purpur., Vacc. uligin., Call. vulg., Echium vulg., Solan. Dulc., Thym. Serp., Nepeta Glech. ♀ F+I+ Stachys Beton., Scutell. albida, Prun. vulg. F+I+, Ajug. rept., Prim. elat. ♀ F+I+, Orchis latif., O. masc. F+I+, O. Morio F+I+.

1358. B. consobrinus *Dahlb.*—Aconit. Lycoct. F+I+.

1359. B. cullumanus (K.) *Thoms.*—Card. crisp.

1360. * B. derhamellus *K.* (=*B. rajellus K.*, cf. No. 1391) ♀ 13, ☿ 10 mm.—Cardam. prat., Brass. oler., Helianth. vulg., Viola odor., V. can., Malva sylv., Trif. rep. ♀, ☿ and ♂ F+I+, T. prat. ♀, ♂ and ♂ F+I+, T. arv. ☿, Lotus corn. ♀ and ☿ F+I+, Vicia Cracca ☿ and ♂ F+I+, V. Sep. ♀ and ☿ F+I+, Lathyr. prat. ♀ and ☿ F+I+, L. sylvest. ♂ ? F+I+, Prunus Cer., Rubus Id., Cydon. jap., Epil. angust., Lythr. Sal. ☿ F+I+, Ribes Gross., Symphoric. racem. ♀ and ☿ F+I+, Lonic. tatar., Knaut. arv., Succ. prat., Solidag. Virgaur., Tanac. vulg., Cirs. arv., Carl. vulg., Centaur. Scab., Leont. aut., Tarax. off., Campan. rot., Vacc. Myrt., Call. vulg., Eric. Tetr., Gent. Pneum., Symph. off., Antirrh. maj., Rhinanth. maj., Salv. prat. ♀ F+I+, S. glutin. ? F+I+, Thym. Serp., Nepeta Glech. ♀ F+I+, Lam. alb. ♀ F+I+, L. purp. ♀ and ☿ F+I+, L. Galeobd. ♀ and ☿ F+I+, Galeops. Tetr. ♀, ☿ and ♂ F+I+, Stach. sylv. ♀ F+I+, Ajug. rept. F+I+, Salix Capr., S. alba, S. fragil.

1361. B. distinguendus *Mor.* ☿ 10½ mm.—Saroth. scop. F+I+, Ononis spin. ♀ F+I+, Trif. rep. ♀ and ☿ F+I+, T. prat. ♀, ☿ and ♂ F+I+, Lotus corn. ☿ F+I+, Vicia Cracca ☿ F+I+, Lathyr. prat. ♀ and ☿ F+I+, Geum riv., Epil. angust., Lythr. Sal. ♀ F+I+, Eryng. marit., Lonic. Xylost. ♀ F+I+, Knaut. arv., Cirs. pal., Card. nut., Leont. aut., Tarax. off., Hierac. umbell., Call. vulg., Eric. Tetr., E. cin., Anchusa off., Echium vulg., Lycium vulg., Rhinanth. maj., Thym. Serp., Lam. alb. ♀ and ☿ F+I+, Galeops. Tetr. ♀, ☿ and ♂ F+I+, Stach. pal. F+I+, Ajug. rept. F+I+, Armer. elong., Salix cin., S. Capr., S. aurit., S. rep., Orchis latif. F+I+.

1362. *B. elegans Seidl.* (=B. mesomelas *Gerst.*, cf. Nos. 1378 and 1386).—Echium. vulg.

1363. B. gerstaeckeri *Mor.* (cf. No. 1383).—Aconit. Nap. F+I+, A. Lycoct. F+I+, A. Anthora ☿ F+I+, Gent. asclep.

1364. B. haematurus *Kriechb.*—Echium vulg., Salv. Sclar.

1365. B. hortorum *L.* (cf. Nos. 1353 and 1392), ♀ 19–21 mm., ☿ 14–16 mm., ♂ 15 mm.—Pulsat. vulg. F+I+, P. prat. F+I+, P. patens, Anem. nemor, Aquileg. vulg. F+I+, A. chrysantha, Delphin. elat. F+I+, D. Consolida F+I+, D. Ajacis F+I+, Aconit. Nap. ♀ F+I+, F±I+, A. variegat. ♀, ☿ and ♂ F+I+, A. Lycoct. ♀ and ☿ F+I+, A. Lycoct. var. pyren. F+I+ A. Cammar., Chelidon. majus, Diclytra spectab. F+I+, Arab. alb., Brass. oler., Sinap. arv., Viola odor., V. tric. vulg. F+I+, V. tric. arv. F+I+, Polyg. Chamaeb., P. serpyll., Dianth. plumar., Sil. nut., Melandr. rubr., Malva sylv., Althaea rosea, A. off., Hyper. perfor., Acer. Pseudoplat., Aesc. Pavia, A. macrost., Geran. sylv., G. phaeum, G. Robert., Tropaeol.

majus F+I+, Impat. Noli-tang. F+I+, I. Balsam., Saroth. scop. ♀ F+I+, Cytis. Lab. ♀ F+I+, Thermopsis fabac., Lupin. hirs., Medic. sat. F+I+, M. falc., M. sylvestr., M. lupul. F+I+, Melilot. off. F+I+, Trif. rep. ☿ F+I+, T. prat. ♀, ☿ and ♂ F+I+, T. pann., Anthyll. Vuln. ♀ and ☿ F+I+, Lotus corn. ♀ and ☿ F+I+, Astrag. glycyph. ♀, ☿ and ♂ F+I+, A. dan., A. exscapus, A. alopecuroid., A. narbon., A. Onobr., Coron. var. F+I+, Hedys. obsc., Vicia Cracca ♀, ☿ F+I+, V. Sat. F+I+, V. Faba ♀ F+I+, V. unijuga, Lathyr. marit. ☿ F+I+, L. sylvest. ♀ and ☿ F+I+, L. mont. ♀ F+I+, L. varieg., L. vernus, L. cirrhos., Orobus Jordani, Phaseolus vulg. ♀ F+I+, P. multifl. ♀ F+I+, Prunus dom., P. avium, P. Cer., Rubus frutic., R. Id., Geum riv., Crat. Oxyac., Pyrus Malus, Epil. angust., Oenoth. bien. ♀ F+I+, O. biennis × O. muric., O. Lamarck., Saxifr. (Bergenia) crassif., Dauc. Car., Symphoric. racem. ☿ F+I+, Lonic. Pericl. ♀ and ♂ F+I+, Cephal. alp., Knaut. arv., Succ. prat., Helianth. an., Senec. Jacob., Cirs. arv., C. lanceol., C. heteroph., C. spinos., C. glabr., Card. nut., Onopord. Acanth., Carl. acaul., Saussur. albesc., Centaur. nigr., C. mont., Tarax. off., Crep. bien., Hierac. umbell., Jas. mont., Vacc. Myrt., V. uligin., V. Vit.-id., Call. vulg., Eric. Tetr., E. carn., Syring. vulg., S. pers., Vinca min., Phacel. tanacetif., Polemon. caerul., Caccinia strig., Arnebia echioid., Anchus. off., A. ochrol., Lycops. arv., Symph. off., S. tuber., S. grandifl., S. peregr., Pulm. off., P. angustif., Echium vulg., E. rosul., Lycium vulg., Solan. Dulc., Verbasc. Thaps., Scroph. nod. ☿ F+I+, Antirrh. maj., A. sempervir., Linar. vulg., Digit. purp., D. lutea, D. ambig., Melamp. prat., M. arv., M. nemor., Pedic. sylv., Rhinanth. maj., Euphras. off., Lathr. Squam., Clandest. rectifl., Acanth. spin., Mentha aquat., Salv. prat. ♀ and ☿ F+I+, S. glutin. ♀ F+I+, ♂ (F+I+) F±I+, S. off. ♀ and ☿ F+I+, S. verticill. F+I+, S. Bertol., S. Baumg., S. controv., S. sclareoid., Origan. vulg., Thym. Serp., Calam. alpina, Nepeta melissif., N. macr. ☿ and ♂ F+I+, N. granat., N. Glech. ♀ and ☿ F+I+, Melitt. Melissophyll. F+I+, Lam. alb. ♀ and ☿ F+I+, L. mac. ♀ and ☿ F+I+, L. mac. var. hirs. ☿ F+I+, L. purp. ♀ F+I+, L. amplexic. ♀ F+I+, L. Orvala, L. gargan., L. flexuos., L. Galeobd. ♀ F+I+, Galeops. Tetr. ♀ F+I+, G. ochrol. ♀ and ♂ F+I+, G. Ladan. ♂ F+I+, G. versic. ♀ F+I+, Stach. sylv. F+I+, S. pal. F+I+, S. Beton., S. orient., Phlom. tuber. ☿ F+I+, P. Russel., P. armen., Ball. nigr. F+I+, Leon. Marrub., Scutell. alp. ?, S. peregr., Prun. vulg. F+I+, Ajug. rept. F+I+, Teucr. Scorod. F+I+, T. Cham. F+I+, Prim. elat. ♀ and ☿ F+I+, P. veris, P. vulg. F+I+, Statice Limon., Polygon. Pers., Daphne Mez., Salix cin., S. Capr., S. aurit., Orchis latif. F+I+, O. masc. F+I+, O. Morio F+I+, O. trident., Epipact. pal. F+I+, Gladiol. pal., Iris Pseudac. F+I+, I. pyren., I. sibir., I. germ., Fritill. imper., Scilla patula, Hyac. orient., Polygonat. multifl., Colchic. aut., Veratr. alb.

1366. B. hortorum *L.* var. nigricans *Schmiedekn.*—Tropaeol. majus F+I+, Impat. Noli-tang. F+I+, Trif. prat. ☿ and ♂ F+I+, Succ. prat., Call. vulg., Linar. vulg., Calam. alpina, Lam. alb. ♀ F+I+.

1367. B. hyperboreus *Schönh.*—Oxytrop. camp., Astrag-alpin., Pedic. sudet.

1368. B. hypnorum *L.* ♀ 11–12 mm., ☿ 8–10 mm.—Geran. sylv., Rhamnus cathart., Astrag. alp., Rubus frutic., R. odor., R. Id., Geum riv., Epil. angust., Ribes nigrum, R. Gross., Cephal. radicata, Knaut. arv., Scab. atrop., Tussil. Farf., Solidag. Virgaur., Helianth. an., Senec. nemor., Echinops exalt., Cirs. pal., Card. crisp., C. nut., Onopord. Acanth., Tarax. offic., Prenanth. purpur., Campan. rot., Call. vulg., Asclep. Syr. F+I+, Vinca min., Conv. sep., Anchus. off., Symphyt. off., S. peregr., Echium vulg., Solan. Dulc., Rhinanth. maj., Thym. Serp., Lam. alb. ♀ F+I+, Ball. nigr. ☿ F+I+, Prun. grandifl., Teucr. Scorod. ♀ and ♂ F+I+, Salix nigric., S. glauca, S. lapp., S. phyllicif.

1369. B. jonellus *K.* (=*B. scrimshiranus K.*, cf. No. 1393), ♀ 12, ☿ 9¾–11½ mm.—Aconit. Lycoct. F±I+, Viola odor., Rhamn. Frang., Rubus frutic., R. Id., R. spectab., Epil. angust., Ribes Gross., Symphoric. racem. ☿ and ♂ F+I+, Succ. prat., Tussil. Farf., Tarax. off., Vacc. Myrt., V. Vit.-Id., Call. vulg., Eric. Tetr., Veron. Cham., Salv. verticill. F+I+, Thym. Serp., Nepeta Glech. ♀ F+I+, Lam. alb. ♀ and ☿ F+I+, L. Galeobd. ♀ and ☿ F+I+, Prun. vulg. F+I+, Ajug. rept. F+I+, Salix alba, S. fragl., S. rep., Scilla sibir.

1370. *B. italicus F.* (=B. pascuorum *Scop.*, cf. No. 1384).—Indigof. macrostach., Lobel. syph., Asclep. syr. F+I+, Acanth. spin.

1371. B. kirbyellus *Curt.* (=*B. nivalis Dahlb.*, cf. No. 1382).—Geran. sylv.

1372. * B. lapidarius *L.* ♀ 12–14 mm., ☿ 10–12 mm., ♂ 8–10 mm.—Thalictr. flavum, Pulsat. vulg. F+I+, Hellebor. foetid. F+I+, H. viridis F+I+, Nigella damas. ☿ and ♂ F+I+, N. sativa ☿ and ♂ F+I+, N. arv. ☿ F+I+, Delphin. Consolida F+I+, Berb. aquif., Papaver Rhoeas, Chelidon. majus, Corydal. lutea, Barbar. vulg., Arab. alb., Hesper. matron., Brass. oler., Sinap. arv., Lunar. ann. ♀ and ☿ F+I+, Iber. amara, Cak. marit., Raphan. Raphan., Helianthem. vulg., Viola odor. ☿ F+I+, V. can. ☿ F+I+, V. can. var. flavicorn., V. tric. vulg. F+I+, Polyg. vulg., P. Chamaeb., Sil. infl., Coron. Fl.-cuc., Malva sylv., M. Alcea, Tilia ulmif., Hyper. perfor., Acer Pseudoplat., Aesc. Hippocast. ☿ F+I+, Geran. pyren., G. phaeum, G. Robert., G. iber., Impat. Noli-tang., I. grandulif. F+I+, Dictamn. albus, Saroth. scop. F+I+, Genista tinct., G. germ., Ulex europ. ☿ F+I+, Cytis. Lab. ♀ and ☿ F+I+, C. sagitt., Lupin. lut. ♀ and ☿ F+I+, L. angustif. ☿ F+I+, L. polyph., Ononis spin. ♀ and ☿ F+I+, Medic. sat. F+I+, Melilot. albus ☿ F+I+, Trif. rep. ♀, ☿ and ♂ F+I+, T. fragif. ☿ and ♂ F+I+, T. prat. ♀ ☿ and ♂ F+I+, T. incarn. ☿ F+I+, T. arv. ☿ F+I+, Anthyllis vuln. ☿ F+I+, Lotus corn. ♀ and ☿ F+I+, Tetragonol. siliqu., Colutea arb. ♀ F+I+, Robinia viscosa, Caragana arboresc., Astrag. glycyph. ☿ F+I+, Coron. var. ☿ F+I+, Hippocrep. com., Hedys. obsc., Onobr. viciif., Vicia sep. ♀ and ☿ F+I+, V. sat. ♀ and ☿ F+I+, V. pannon., V. Faba ♀ F+I+, V. pisiform. ♀ F+I+, V. unijuga, Lathyr. prat. ☿ F+I+, L. marit. ☿ F+I+, L. mont. ☿ F+I+, L. nigr. ☿ F+I+, L. vernus, L. brachypt., L. cirrhos., Orobus aur., Persica vulg., Prunus dom., P. avium, P. Cer., P. spin., Rubus frutic., R. caes., R. odor., R. Id., Geum riv., Pyrus Malus, Epil. angust., Oenoth. bien. F+I+, O. Lamarck., Lythr. Sal. ♀, ☿ and ♂ F+I+, L. hyssopif., Philad. coron., Deutzia crenata, Sedum Teleph., S. Aizoön, Ribes Gross., Astrantia maj., Eryng. marit., E. camp., Symphoric. racem. ☿ F+I+, Lonic. caerul., L. iber., Dipsac. sylv., D. Full., Knaut. arv., Succ. prat., Scab. Columb., S. luc., S. dauc., Eupat. can., Vernon. fascic., Aster Trip., A. Novae-Angl., Solidag. Virgaur., Dahlia variab., Pulic. dysent., Actinom. helianth., Helianth. an., Rudb. lacin., Matric. inod., Cacal. hast., Senec. Jacob., Echinops sphaeroc., Cirs. arv., C. lanceol., C. pal., C. rivul., C. olerac., Card. crisp., C. acanth., C. nut., Onopord. Acanth., Carl. acaul., C. vulg., Centaur. Jac., C. nigr., C. mont., C. Cyan., C. Scab., C. Calcitr., Thrinc. hirt., Leont. aut., Hypoch. radic., Tarax. off., Mulged. alpin., Sonchus arv., S. asp., Crep. bien., Hierac. umbell., Campan. rot., C. rapunculoid., C. Trach., C. Rapunc., C. barb., Phyteuma spic., P. nigr., Jas. mont., Vacc. Myrt., V. uligin., V. Vit.-id., Androm. polif., Call. vulg., Eric. Tetr., E. cin., Syring. vulg., Vinca min., Gent. Pneum, Polemon. caerul., Anchus. off., A. ochrol., Symph. off., S. tuber., S. grandifl., Pulm. off., Cerinthe min., Echium vulg., Lithosperm. arv., Lycium vulg., Solan. Dulc., Atropa Bell., Hyosc. nig., Scroph. nod. ☿ F+I+, Antirrh. maj., A. Oront., Linar. vulg., Pentstem. campan., Melamp. prat., M. nemor., M. cristat., Pedic. sylv., Euphras. Odont., E. off., Lathr. Squam., Mentha aquat., Salv. off. ♀, ☿ and ♂ F+I+, Origan. vulg., O. maj., Thym. Serp., Calam. off., Clinop. vulg., Hyssop. off. ♂ F+I+, Nepeta Glech. ♀ and ☿ F+I+, Dracoceph. mold., Lam. alb. ♀ and ☿ F+I+, L. alb. var. verticill. ♀ F+I+, L. mac. ♀ F+I+, L. purp. ♀ F+I+, L. Galeobd. ♀ F+I+, Molucella laev. ♂ F+I+, Galeops. Tetr. ♂ F+I+L, G. ochr., ♀ F+I+, G. Ladan. F+I+, Stach. sylv. ♀ F+I+, S. pal. F+I+, S. germ. var. dasyantha F+I+, S. cretica, S. Beton. ♀ F+I+, Siderit. scordioid., Ball. nigr. ☿ F+I+, Leon. Card., Prun. vulg. ♀, ☿ and ♂ F+I+, Ajug. rept. F+I+, Teucr. Scorod. F+I+, Prim. elat. ♀ F+I+, Armer. elong., Plantag. med., Polygon. Fagop., Salix cin., S. Capr., S. aurit., S. alba, S. fragil., S. rep., Orchis latif. F+I+, O. masc. F+I+, O. Morio F+I+, Allium vin., Polygonat. off.

1373. B. lapponicus *F.*, ♂ 12–13 mm., ♀ 9–12 mm., ♂ 10 mm.—Sil. acaul., Trif. rep. ☿ and ♂ F+I+, Astrag. arg., Tanac. vulgar., Tarax. off., Vacc. uligin., Call. vulg., Pedic. lappon., Polygon. vivip., Salix nigric., S. glauca, S. lapp., S. phyllicif.

1374. *B. latreillellus K.* (=B. subterraneus *L.*, cf. No. 1399).—Viola tric. vulg. F+I+, Trif. prat. ♀, ☿ and ♂ F+I+, Cirs. olerac., Vacc. Myrt., Gent. asclep., Anchusa off., Salv. prat. F+I+, Ball. nigr. F+I+.

1375. B. lucorum *L.* (=var. of B. terrester *L.*, cf. No. 1401).—Chelidon. majus, Iber. amara, Cak. marit., Viola odor., Aesc. Pavia, Medic. sylvestr., Trif. rep. ☿ F+I+, T. prat. ♀ and ☿ F±I+, T. arv. ☿ F+I+, Lathyr. prat. ☿ F+I+, Rubus frutic., R. caes., R. Id., R. spectab., Cyton. jap., Pyrus comm., Ribes Gross., Symphoric. racem. ☿ and ♂ F+I+, Lonic. tatar., Knaut. arv., Succ. prat., Petas. off., Cirs. arv., Leont. aut., Tarax. off., Campan. rot., Jas. mont., Call. vulg., Eric. tetr., Symph. off., Lycium vulg., Antirrh. maj., Thym. Serp., Lam. alb. F+I+, F±I+, Stach. pal. F+I+, Ball. nigr. F+I+, Salix alba, S. fragil., S. rep., Epipog. aphyll., Scilla sibir.

1376. B. mastrucatus *Gerst.* (cf. No. 1355), ♀ 10–12½ mm., ☿ 9–10 mm.—Aconitum Nap., Corydal. cava F±I+, Polyg. Chamaeb. ♀ F+I+, F±I+, ☿ F±I+, Sapon. ocym., Cytis. nigric., Melilot. off. F+I+, Trif. mont. ♂ F+I+, T. prat. ♂ F+I+, Lotus corn., Oxytropis camp., Astrag. alp., Vicia sep. ☿ F±I+, V. Orobus, Lathyr. mont. ? F+I+, L. vernus, Epil. angust., Solidag. Virgaur., Senec. Jacob., Cirs. spinosis., Prenanth. purpur., Crep. aurea, Phyteuma hemisph., Vacc. Myrt., Call. vulg., Rhodod. hirs., Gent. campestr., G. obtusif., Linar. vulg., L. alpina ?, Melamp. nemor., Pedic. sylv., Rhinanth. maj., R. major. var. hirs., Salv. prat. F+I+, S. glutin. F±I+, Calam. alpina, Hormin. pyren. F±I+, Lam. mac., Galeops. Tetr., Ball. nigr., Prun. grandifl., Prim. visc., Orchis sambuc., Goodyera rep.

1377. B. mendax *Gerst.*, ♀ 13–17 mm., ☿ 11–13 mm.—Aconit. Nap. F±I+, Oxytrop. ural., Rhodod. hirs., Veron. off., Ball. nigr. ♀, ☿ and ♂ F+I+.

1378. B. mesomelas *Gerst.* (cf. Nos. 1362 and 1386), ♀ 15–18 mm., ☿ 12–14 mm., ♂ 9–10 mm.—Trif. prat. ♀, ☿ and ♂ F+I+, Scab. Columb., Cirs. heteroph., Card. nut., Salv. verticill. F+I+, Lam. alb.

1379. *B. montanus Lep.*—Rhodod. hirs.

1380. B. mucidus *Gerst.*—Trif. alpin., Salv. verticill. F+I+.

1381. B. muscorum *F.* (=*B. cognatus Steph.*, cf. No. 1356), ♀ 15 mm.—Viola tric. vulg. F+I+, Saroth. scop. F+I+, Genista angl. F+I+, Trif. rep. ☿, F+I+, Trif. prat. ♀, ☿ and ♂ F+I+, T. incarn. F+I+, T. arv. ☿ F+I+, Anthyll. Vuln. ☿ F+I+, Lotus corn. ♀ and ☿ F+I+, Vicia Cracca ♀ F+I+, V. sep. ♀ and ☿ F+I+, V. angustif. ☿ F+I+, V. Faba ♀ F+I+, Lathyr. prat. ♀ F+I+, Symphoric. racemos. ♂ F+I+, Valerian. olit., Dipsac. sylv., Knaut. arv., Succ. prat., Eupat. can., Tanac. vulg., Senec. nemor., Echinops Sphaeroc., Onopord. Acanth., Carl. acaul., Leont. aut., Hypoch. radic., Tarax. off., Sonchus arv., Hierac. umbell., Jas. mont., Vacc. Myrt., V. Vit.-id., Androm. polif., Call. vulg., Eric. tetr., Gent. Pneum., G. acaule, G. verna, Anchus. off., Pulm. off., Lycium vulg., Digit. purp., Melamp. sylv., Pedic. sylv., Rhinanth. maj., Euphras. Odont., E. off., Lathr. Squam., Salv. prat. F+I+, Thym. Serp., Calam. Acin., Nepeta Glech. ♀ F+I+, Lam. alb. ♀ and ☿ F+I+, L. purp. ♀ F+I+, L. amplexic. ♀ F+I+, L. Galeobd. ♀ F+I+, Galeops. Tetr. ♀ and ☿ F+I+, Stach. pal. F+I+, S. recta F+I+, S. Beton., Ball. nigr. ☿ F+I+, Prun. vulg. F+I+, Ajug. rept. F+I+, Teucr. Scorod., Salix alba, S. fragil., S. rep., Orchis latif. F+I+.

1382. *B. nivalis Dahlb.* (=B. kirbyellus *Curt.*, cf. No. 1371).—Oxytrop. camp., Lathyr. marit. ☿ and ♂ F+I+, Comar. pal., Polygon. vivip., Salix nigric., S. glauca, S. lapp., S. phyllicif.

1383. *B. opulentus Gerst.* (=G. gerstaeckeri *Mor.*, cf. No. 1363), ♀ 21–3 mm.—Aconit. Lycoct. F+I+.

1384. B. pascuorum *Scop.* (=*B. italicus F.*, cf. No. 1370).—Althaea rosea, Agrim. Eupat., Centaur. Jac., Rosmar. off., Ball. nigr. ♂ F+I+.

1385. B. pomorum *Pz.*—Corydal. lutea, Cardam. prat., Polyg. Chamaeb., Medic. sat. ♂ F+I+, Trif. prat. ♀, ☿ and ♂ F+I+, T. arv. ☿ F+I+, Vicia sep. F+I+, Epil. mont., Lonic. Xylost. ♀ F+I+, Viburn. Lant., Eupat. can., Helianth. an., Card. crisp., Carl. acaul., Echium vulg., Linar. vulg., Digit. ambig., Salv. off. ♀ F+I+, Stach. pal. F+I+.

1386. *B. pomorum Pz. var. elegans Seidl.* (=B. mesomelas *Gerst.*, cf. Nos. 1362 and 1378).—Trif. alp. F+I+, Anthyll. Vuln., Oxytropis camp., Lonic. Xylost., Carl. acaul.

1387. *B. pomorum Pz. var. rufescens Ev.*—Lam. mac. F+I+.

1388. B. pratorum *L.*, ♀ 12–14½ mm., ☿ 8–12 mm., ♂ —10 mm.—Anem. nem., Aconit. Nap., Berb. vulg., Chelidon. maj., Diclyt. spect. F±I+, Raphan. Raph., Viola odor., V. tric. arv., Polyg. Chamaeb., Malva sylv., Geran.

sanguin., Medic. sat. F+I+, Trif. rep. ♀ and ☿ F+I+, T. mont. ♂ F+I+. T. prat. ♀ and ☿ F+I+, T. camp. ♀ F+I+, Lotus corn., Astrag. arenar., Onobr. viciif., Vicia unijuga, Lathyr. marit. ☿ F+I+, Prunus Cer., Rosa rubigin., Rubus frutic., R. odor., R. Id., Geum riv., Cydonia jap., Epil. angust., Fuchsia sp., Philad. coron., Ribes nigrum, R. sanguin., R. Gross., Saxifr. (Bergenia) crassif., Symphoric. racem. ☿ and ♂ F+I+, Lonic. Xylost. ☿ F+I+, Valer. off., Knaut. arv., Succ. prat., Scab. Columb., Petas. off., Aster Tripol., Helianth. decap., H. mollis, Heliops. laev., Senec. nemor., S. Jacob., Cirs. pal., C. olerac. var. amar., Card. acanth., C. nut., Centaur. Jac., C. nigr., C. mont., C. Scab., C. atropurp., C. leucol., Leont. hast., Tarax. offic., Campan. rot., C. latif., Phyteuma spic., Vacc. Myrt., V. uligin., Call. vulg., Eric. cin., Rhodod. hirs., Forsyth. virid., Vinca min., Polemon. caerul., Cynogloss. Column., Borago off., Anchus. off., A. ochrol., Symph. off., S. off. var. coccin., S. peregr., Pulm. off., Echium vulg., Lycium vulg., Solan. Dulc., Atropa Bell., Scroph. nod. ☿ F+I+, Veron. mont., Melamp. prat., M. nemor., Pedic. palustr., Rhinanth. maj., Euphras. off., Salv. prat. ♀ F+I+, S. off. ♀ and ☿ F+I+, S. verticill. ♀ F+I+, Origan. vulg., Thym. Serp., Nepeta nuda, N. Glech. ♀ F+I+, Lophanth. rug., Lam. alb. ♀ and ☿ F+I+, Lam. purp. ♀ F+I+, L. incis. ♀ F+I+, L. gargan., L. Galeobd. ♀ and ☿ F+I+, Stach. sylv. F+I+, Ball. nigr. F+I+, Leon. Card., L. Marrub., Prun. vulg. F+I+, P. grandifl., Ajuga rept. F+I+, Teucr. Scorod. F+I+, Verben. off., Prim. elat. F+I+, Plantag. lanc., Polygon. vivip., Salix cin., S. Capr., S. aurit., S. vimin., S. nigr., S. glauca, S. lapp., S. phyllicif., Orchis masc. F+I+, O. Morio F+I+, O. macul. F+I+, Goodyera rep., Antheric. ramos., Scilla sibir., Allium ursin., A. vin., Hyac. orient.

1389. B. pratorum *L.* var. subinterruptus *K.*—Symph. off.

1390. B. proteus *Gerst* (cf. No. 1398), ♀ 13–14 mm., ☿ 11–13 mm.—Malva sylv., Rham. Frang., Trif. rub., Rub. frutic., R. Id., Epil. angust., Knaut. arv., Succ. prat., Cirs. arv., C. olerac., Lappa min., Leont. aut., Campan. rot., Phyteuma spic., Jas. mont., Vacc. Myrt., V. uligin., V. Vit.-id., Call. vulg., Linar. vulg., Thym. Serp., Lam. alb. F+I+, Stach. pal. F+I+, Teucr. Scorod. F+I+.

1391. B. rajellus *K.* (=*B. derhamellus K.*, cf. No. 1360), ♀ 13–14 mm., ☿ 12–13 mm., ♂ 10–11 mm.—Chelidon majus, Diclytra spectab. F±I+, Corydal. lutea, Viola tric. arv. F+I+, Polyg. Chamaeb., Coron. Fl.-cuc., Hyper. perfor., Acer Pseudoplat., Geran. phaeum, Lupin. lut. ☿ F+I+, L. angustif., Dorycn. hirs., Trif. rep. F+I+, T. prat. ♀ and ☿ F+I+, T. arv. ♀ and ☿ F+I+, T. alpin., Lotus uligin. ☿ F+I+, Astrag. glycyph. ♀ F+I+, Coron. var. ♀ F+I±, C. mont., C. glauca, C. minima, Hedys. sibir., Onobr. aren., Vicia Cracca ☿ F+I+, V. sep. ♀ and ☿ F+I+, V. Faba ♀ F+I+, V. pisiform. ♀ and ☿ F+I+, Cydonia jap., Epil. angust., Oenoth. bien. × D. muric., Sedum acre, Dipsac. sylv., Knaut. arv., Succ. prat., Cirs. pal., Centaur. rhen., Hierac. vulgat., Phyteum. betonicif., Eric. Tetr., Anchus. off., Lycops. arv., Pulm. off., Echium vulg., Lycium vulg., Linar. vulg., Melamp. arv., M. nemor., Pedic. sylv., Rhinanth. maj., Salv. prat. ♀ F+I+, S. off. ♀ F+I+, Nepeta Glech. ♀ F+I+, Lam. alb. ♀ F+I+, L. mac. ☿ F±I+, L. purp. ♀ F+I+, L. incis. ♀ F+I+, L. Galeobd. F+I+, Galeops. Tetr. ♀, ☿ and ♂ F+I+, Stach. pal. F+I+, Ball. nigr. ♀ and ♂ F+I+, Prun. vulg. F+I+, Ajug. rept. F+I+, Prim. off. F+I+, Salix Capr., Iris Pseudac. F+I+.

1392. B. ruderatus *F.* (=a var. of B. hortorum *L.*, cf. Nos. 1353 and 1365), ☿ 22 mm.—Cak. marit., Aesc. Pavia, Cytis. Lab. ♀ F+I+, Trif. prat. ♀, ☿ and ♂ F+I+, Vicia Faba ♀ F+I+, Knaut. arv., Dahlia variab., Helianth. an., Cirs. arv., Card. nut., Tarax. off., Symphyt. off., Echium vulg., Linar. vulg., Salv. prat. F+I+, Lam. alb. ♀ F+I+, Galeops. ochr. ☿ and ♂ F+I+, G. versic. ☿ F+I+, Stach. pal. ♂ F+I+.

1393. *B. scrimshiranus K.* (=B. jonellus *K.*, cf. No. 1369), ☿ 10 mm.—Aconit. Lycoct. F+I+, Trif. rep. ☿ and ♂ F+I+, Astrag. alp., Onobr. viciif., Vicia Cracca ♀, ☿ and ♂ F+I+, Lathyrus heteroph. F+I+, L. pal. F+I+, Rubus frutic., R. Chamaem., Geum riv., Comar. pal., Spir. sorbif., S. salicif., S. ulmif., Epil. angust., Ribes Gross., Tanac. vulg., Cirs. pal., Centaur. nigr., Leont. aut., Tarax. off., Vacc. Myrt., Call. vulg., Limnanth. nymph., Lycops. arv., Verbasc. Thaps., Pedic. sylv., P. palustr., Rhinanth. maj., Lam. alb.,

☿ and ☿ F+I+, Galeops. sp. ?, G. Tetr. ♂ F+I+, Polygon. vivip., Salix cin., S. Capr., S. aurit., S. nigr., S. glauca, S. lapp., S. phyllicif.

1394. *B. senilis F.* (=B. variabilis *Schmiedekn.* and B. muscorum *F.*), ♀ 14–15 mm., ☿ 10–12 mm., ♂ 10 mm.—Delphin. elatum *L.*, Echium vulg., Scroph. nod. F+I+.

1395. * B. sylvarum L., ♀ 12–14 mm., ☿ 10–12 mm., ♂ 9–10 mm.—Aconit. Nap., Brass. oler., Polyg. Chamaeb., Malva sylv., Trif. rep. ♀ F+I+, T. fragif. ☿ F+I+, T. prat. ♀, ☿ and ♂ F+I+, T. rub., Anthyll. Vuln. ☿ F+I+. Lotus corn. ☿ F+I+, Onobr. viciif., Vicia Cracca ♀ and ☿ F+I+, V. sep. F+I+, V. sat. ♀ F+I+, V. angustif. ♀ F+I+, V. Faba ♀ F+I+, V. pisiform. ♀ F+I+, Lathyr. prat. ♀ and ☿ F+I+, L. sylvest. ☿ F+I+, L. latif. var. intermed., Rubus frutic., R. Id., Geum riv., Epil. hirs., Oenoth. bien. ♀ F+I+, Lythr. Sal. ☿ F+I+, Sedum Teleph., Ribes Gross., Lonic. tatar., Knaut. arv., Succ. prat., Helianth. an., Calend. offic., Echinops sphaeroc., Cirs. arv., C. lanceol., Card. acanth., C. nut., Lappa toment., Carl. acaul., Centaur. Jac., C. Cyan., C. Scab., Thrinc. hirt., Leont. aut., Tarax. off., Hierac. vulgat., Jas. mont., Vacc. uligin., Call. vulg., Eric. Tetr., Gent. Amarella, Anchus. off., Symph. off., Pulm. off., Echium vulg., Lycium vulg., Antirrh. maj., Linar. vulg., Melamp. prat., M. arv., Pedic. sylv., Rhinanth. maj., Euphras. Odont., Mentha aquat., Lycop. europ., Salv. prat. ♀ and ☿ F+I+, S. off., ♀ F+I+, S. verticill. ♀ and ☿ F+I+, Origan. vulg., Thym. Serp., Nepeta Glech. ♀ F+I+, Lam. alb. ♀ F+I+, L. purp. ♀ F+I+, L. amplexic. ♀ F+I+, L. Galeobd. ♀ F+I+, Galeops. Tetr. ♀ and ☿ F+I+, G. Ladan. ♀ F+I+, Stach. sylv. ♀ F+I+, S. pal. F+I+, S. recta F+I+, Ball. nigr. ♀ F+I+, Prun. vulg. ♀, ☿ and ♂ F+I+, Ajuga rept. F+I+, Teucr. Scorod. F+I+, Prim. elat. F+I+, Orchis Morio F+I+.

1396. B. sylvarum *L.* var. albicauda *Schmiedekn.*—Vicia Cracca ♀ F+I+.

1397. B. soroënsis *F.*—Aconit. Nap. F±I+, Polyg. Chamaeb., Epil. angust., Eryng. marit., Scab. Columb., Eupat. can., Senec. Jacob., Card. crisp., Hierac. muror., Campan. barb., Call. vulg., Euphras. off., Salv. prat. ♀ F+I+, Origan. vulg., Prun. vulg. F+I+.

1398. B. soroënsis *F.* var. proteus *Gerst.* (=B. proteus *Gerst.*, cf. No. 1390).—Viscar. vulg., Tilia ulmif., Trif. arv. ☿ F+I+, Rubus frutic., Knaut. arv., Cirs. arv., Leont. aut., Hierac. Pilosel., H. muror., Campan. rot., Euphras. off., Thym. Serp., Prun. vulg. F+I+.

1399. B. subterraneus *L.* (cf. No. 1374).—Brass. nig., Viola corn., V. tric. vulg. F+I+, V. patens F+I+, Coron. Fl.-cuc., Trif. prat. ♀, ☿ and ♂ F+I+, Lotus uligin., Rubus caes., Heracl. Sphond., Succ. prat., Cirs. arv., Card. crisp., Lappa toment., Centaur. Jac., Leont. aut., Hypoch. glabra, Crep. vir., Hierac. umbell., Call. vulg., Rhinanth. maj., Euphras. Odont., Salv. prat. F+I+, S. verticill. F+I+, Nepeta Glech. ♀ F+I+, Lam. alb. ♀ F+I+, Prun. vulg. F+I+, Ajug. rept. F+I+, Butom. umb.

1400. B. subterraneus *L.* var. borealis *Schmiedekn.*—Ballota nigra F+I+.

1401. * B. terrester (terrestris) *L.* (cf. No. 1375), ♀ 9–10 mm., ☿ 8–9 mm.—Clemat. recta, C. angustif., Pulsat. vulg., Anem. nemor., A. japon., Adon. vern., Batrach. aquat., Ranunc. acris, R. rep., R. lanugin., R. Fic., Caltha pal., Hellebor. foetid., H. viridis F+I+, Nigella sativa ☿ F+I+, N. damasc. ☿ F+I+, Aquileg. vulg. F±I+, Aconit. Nap. ♀ F+I+, F±I+, A. Lycoct. F±I+, Paeon. off., Berb. vulg., B. aquifol., Papaver Rhoeas, P. somnif., Chelidon. majus, Sanguin. canad., Diclytra spectab. F±I+, Corydal. cava F±I+, C. solida F±I+, C. clavicul., Cheirant. Cheiri, Cardam. prat., Brass. oler., Sinap. arv., Eroph. verna, Iber. amara, Cak. marit., Viola odor., V. can. ♂ F+I+, V. tric. vulg. F+I+, V. tric. arv., Polyg. vulg., P. Chamaeb., Sapon. off., S. ocym., Viscar. vulg., Cor. Fl.-cuc., Melandr. rubr., Malva sylv., Alth. ficif., A. off., Tilia ulmif., Hyper. perfor., H. quadrang., H. commutat., H. tetrapt., Acer Pseudoplat., Aesc. Hippocast. ♀ F+I+, A. flava, Geran. pusill., G. Robert., Oxalis Acetos., Impat. Noli-tang. F+I+, I. Balsam., I. glandulif. F+I+, Rhamn. Frang., Saroth. scop. ♀ F+I+, Genista tinct. F+I+, G. angl. F+I+, Ulex europ. ♀ F+I+, Cytis. Lab. ☿ F+I+, C. sagitt., Sophora flavesc., Lupin. lut. ☿ F+I+, L. angustif. ☿ F+I+, Ononis spin. ♀ and ☿ F+I+, O. rep., Medic. sat. F+I+, M. lupul., Dorycn. hirs., Trif. rep. ☿ and ♂ F+I+, T. hybr. ☿ F+I+, T. fragif. ☿ F+I+, T. prat. ♀ and ☿ F±I+, T. med., T. arv. ♀, ☿ and ♂ F+I+, T. alpin., Lotus corn. ☿ F+I+ and F±I+, Astrag. dan., A. exscap., A. alp., Onobr. viciif.

Vicia sep. ♀ and ☿ F±I+, V. sat. F±I+, V. Faba ♀ F±I+, Lathyr. prat. F+I+, L. latif., L. niger F±I+, L. vern., L. brachypt., Phaseolus vulg. F±I+, P. multiflor. F±I+, Amygd. comm., Persica vulg., Prunus dom., P. avium, P. Cer., P. spin., Rosa pimpinellif, R. rubigin., Rubus frutic., R. caes., R. Id., Geum riv., G. urb., Potent. Anser., P. verna, Agrim. Eupat., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., C. monog., Cydonia jap., Pyrus Malus, P. comm., Sorbus Auc., Epil. angust., E. hirs., Oenoth. bien. F+I+, Fuchsia sp., Lythr. Sal. ♀, ☿ and ♂ F+I+, L. hyssopif., Deutzia crenata, Sedum Teleph., Ribes nigrum, R. sanguin., R. Gross., Saxifr. (Bergenia) crassif., Astrant. maj., Eryng. camp., E. gigant., Levist. off., Ligustic. commut., Angel. sylv., Heracl. Sphond., Dauc. Car., Viburn. op., Symphor. racem. F+I+, Valer. mont., V. alliariif., Dipsac. sylv., D. Full., Cephal. alp., C. ural., C. ural. var. cret., Knaut. arv., Succ. prat., Scab. dauc., Eupat. purp., Vernon. fascic., V. praeal., Adenost. alp., Tussil. Farf., Petas. off., Aster Tripol., A. Amel., A. Nov.-Angl., A. salicif., A. panicul. var. pubesc., A. sagitt., A. sparsifl., Bellis per., Diplopap. amygd., Solidag. Virgaur., S. ambig., S. fragr., S. laterifl., Dahlia variab., D. Cerv., Silph. Aster., S. connat., S. erythroc., S. gummif., S. trifol., Bidens cern., Helianth. an., H. atror., H. decap., H. Maximil., H. moll., Echinac. purp., Heliops. lacr., H. Scab., Rudb. lacin., Tanac. vulg., Chrys. Leuc., Cacal. hast., Senec. nemor., S. Jacob., Echinops sphaeroc., E. bannat., E. exalt., Cirs. arv., C. lanceol., C. olerac., C. acaule × C. olerac., Card. crisp., C. acanth., C. deflor., C. nut., Onopord. Acanth., Carl. acaul., C. vulg., Alfred. cern., Serrat. quinquef., Centaur. Jac., C. nigr., C. Scab., C. astrach., C. atropurp., C. atropurp. var. ochrol., C. conglom., C. rup., C. ruthen., C. salicif., Leont. aut., Picr. hierac., Tarax. offic., Sonchus arv., Crepis vir., Hierac. vulgat., H. umbell., H. brevifol., Lobel. erin., L. syph., Jas. mont., Vacc. Myrt., V. uligin., V. Vit.-Id., Arbut. Uned., Call. vulg., Eric. Tetr., E. cin., Rhodod. praec., Syring. vulg., Asclep. syr. F+I+, Vinca min., V. maj., Gent. Pneum., G. obtusif., Hydroph. virgin., Polemon. caerul., Conv. arv., C. sep., C. Soldan., Cynogloss. off., Omphalod. verna, Anchusa off., Symph. off., S. asperr., S. peregr., Pulm. off., P. angustif. × P. off., Onosma Stell., Cerinthe min., Echium vulg., E. rosul., Lycium vulg., Solan. Dulc., S. nigr., Atropa Bell., Hyosc. nig., Verbasc. Thaps., V. nigr., Scroph. nod., Antirrh. maj., A. Oront., Linar. vulg., L. pyren. ?, L. ital., Digit. purp., D. lutea, D. ambig., Veron. longif., Melamp. prat., M. arv., M. nemor., Pedic. sylv., P. palustr., Rhinanth. maj., R. min., Euphras. Odont., Lathr. Squam., Acanth. spin., Mentha arv., Salv. sylv. F+I+, S. off. F±I+, S. Bertol., Monarda did., M. fistul., M. fistul. vars. mollis. albicans and purpur., Origan. vulg., Satureia mont., Thym. Serp., T. dalm., Calam. alpina, C. off., C. Nepeta, Clinop. vulg., Melissa off. ☿ and ♂ F+I+, Hormin. pyren. F±I+, Nepeta Cat. ☿ F+I+, N. Glech. ♀ flowers F+I+ and F±I+, ☿ flowers F±I+, Rosmar. off., Hyssop. off., Dracoceph. mold., Melitt. Melissophyll. F±I+, Lam. alb. F±I+, L. mac. F±I+, L. purp. ♀ and ☿ F+I+, L. amplexic. ♀ F+I+, L. Galeobd. F±I+, Galeops. Tetr. F±I+, G. versic. ♀ F+I+, Stach. pal. ♀ F+I+ and F±I+, S. germ. ♀ and ♂ F+I+, S. lanata, S. rubic., Phlom. Russel., Siderit. hyssopif., S. scordioid., Marrub. vulg. F+I+, M. candidiss., M. anisod., Ballota nigra F+I+, Leon. lanat., Scutell. galer. F+I+ and F±I+, S. albida, Prun. vulg. ☿ F+I+, P. grandifl., Ajuga rept. F+I+, Teucr. Scorod., T. Cham., T. canum, Verben. urticif., Prim. elat. F±I+, Armer. elong., Statice Lim., Plantag. lanc., P. med., Polygon. vivip., Daphne Mez., Salix aurit., S. Capr., S. cin., S. aurit. S. purp., S. alba, S. fragil., S. vimin., S. nigric., S. rep., Butom. umb., Orchis latif. F+I+, O. masc. F+I+, Croc. varieg., Fritill. Meleagr., F. lutea, Scilla sibir., Allium Cepa, Hyac. orient., H. candic.

1402. B. terrester *L.* var. audax *Harv.* (=B. virginalis *Fourcr.*).—Antirrh. maj.

1403. *B. tristis Seidl.* (=B. variabilis *Schmiedkn.* var. tristis *Seidl.*, cf. No. 1405).—Knaut. arv., Carl. vulg., Thrinc. hirt., Anchus. off., Lycium vulg., Salv. verticill. ♀ F+I+, Stach. pal. F+I+, S. recta F+I+, Ball. nigr. ☿ F+I+, Leon. Card., Teucr. Cham.

1404. * B. variabilis *Schmiedkn.*, ♀ 13 mm.—Raphan. Raph., Medic. sat. ☿ F+I+, Trif. prat. ♀, ☿ and ♂ F+I+, T. incarn. F+I+, Lotus corn. ☿ F+I+, Astrag. alp., Vicia sep. F+I+, Rubus frutic., R. caes., Lythr. Sal. F+I+,

Succ. prat., Eupat. can., Echinops sphaeroc., Centaur. Scab., C. rhen., Thrinc. hirt., Hierac. Pilos., Vacc. Myrt., Call. vulg., Eric. Tetr., Echium vulg., Veron. spic., Melamp. arv., Euphras. Odont., Salv. prat. F+I+, Thym. Serp., Calam. Acin., Lam. alb. ♂ F+I+, L. purp. F+I+, Galeops. Tetr. ☿ F+I+, Stach. recta F+I+, S. Beton. F+I+, Prun. vulg. F+I+, Teucr. Scorod. F+I+, T. Cham., Iris sibir.

1405. B. variabilis *Schmiedekn.* var. tristis *Seidl.* (cf. No. 1403).—Cytis. sagitt., Ononis rep., Trif. rub., Astrag. glycyph. ☿ F+I+, Vicia sep., Echium vulg.
1406. B. vorticosus *Gerst.*—Symphyt. asperrim.
1407. B. zonatus *Sm.*—Teucr. Cham.
1408. Bombus sp.—Clemat. Balear., Lotus uligin. F±I+, Astrag. glycyph. F±I+ Lathyr. mont. F±I+, Passifl. caer. F+I+, Persica vulg., Eryng. Bourgati, Conium macul., Cicuta virosa, Oenan. crocata, Ebul. humil., Lonic. nigra, L. caerul., Valer. off., Dipsac. Full., Homogyne alp., Bidens trip., Matric. Cham., Tanac. vulg., Chrys. Leuc., Cirs. erioph., C. heteroph., C. acaule, C. monsp., C. ochrol., Card. acanth., C. Person., Lappa min., L. maj., Carl. Acaul., C. acanth., C. vulg., Saussur. alp., Centaur. nigr., C. axill., C. Müreti, C. Cyan., C. Scab., C. nerv., Aposer. folt., Thrinc. hirt., Leont. aut., L. hast., Picr. hierac., Tarax. off., Mulged. alpin., Sonchus olerac., S. arv., Crep. vir., Hierac. albid., H. vulgat., H. muror., H. umbell., Campan. rot., Phyteuma paucifl., Conv. arv., Nicot. rustica × N. panicul. F±I+, Pedic. Oederi, P. rostr., P. asplenif., P. foliosa, P. verticill., P. tuber., Rhinanth. alp., R. min., Barts. alp., Ocymum, Stach. annua, Prun. alb., Teucr. pyren., Cyclam. persic., C. repand., Salix herbac., S. polar., Spiranth. aut., Calypso bor., Stanhop. tigr., Gladiol. seget., G. Gandav., Allium fallax, Polygonat. multifl., Bulbocod. aut.
1409. Camptopoeum frontale *F.*—Centaur. Biberst.
1410. *Ceratina albilabris F.* (=C. cucurbitina *Rossi*, cf. No. 1412).—Jas. mont., Echium vulg.
1411. C. callosa *F.*—Nigella damasc., Knaut. arv., Hierac. Pilos.
1412. C. cucurbitina *Rossi* (cf. No. 1410).—Res. lutea, Cist. monspel., Erod. cicut., Paliur. acul., Orlaya grand., Card. pycnoceph., Centaur. rhen., Conv. cantabr., Echium vulg., Ajug. genev., Teucr. flavum, Verben. off.
1413. C. cyanea *K.*—Melilot. off. F+I+, Rubus caes., Knaut. arv., K. sylv., Hierac. Pilos., Campan. glom., Jas. mont., Echium vulg., Verben. off.
1414. C. gravidula *Gerst.*—Centaur. rhen.
1415. C. nigroaenea *Gerst.*—Card. nut., Thym. Cham.
1416. *Chalicodoma manicata Gir.* (=Megachile manicata *Gir.*, cf. No. 1625).—Thym. Serp., Rosmar. off., Ajug. genev.
1417. *C. muraria Retz.* (=Megachile muraria *Retz.*, cf. No. 1628), ♀ 10 mm.—Lotus corn. ♀ F+I+, Onobr. viciif., Salv. prat. ♀ and ♂ F+I+, Ajug. genev.
1418. *C. pyrenaica Lep.* (=Megachile pyrenaica *Lep.*, cf. No. 1633).—Trif. prat. F+I+.
1419. *Chelostoma campanularum K.* (=Eriades campanularum *K.*, cf. No. 1482), 3 mm.—Malva sylv., Geran. prat., G. molle, G. Robert., Sedum album, Card. acanth., Cichor. Int., Sonchus asp., Crep. bien., C. vir., Hierac. folios., Campan. rot., C. bonon., C. rapunculoides, C. Trach., C. persic., C. carpath., Jas. mont., Polemon. caerul., Conv. arv., Salv. off. ♀ F+I+.
1420. *C. florisomne L.* (=Eriades florisomnis *L.*, cf. Nos. 1421 and 1484).—Leont. aut., Tarax. off., Hierac. vulgat., Campan. bonon., Lam. purp. ♀ F+I+.
1421. *C. maxillosum L.* (=Eriades florisomnis *L.*, cf. Nos. 1420 and 1484).—Ranunc. acris, R. rep., R. bulb., Tarax. off.
1422. *C. nigricorne Nyl.* (=Eriades nigricornis *Nyl.*, cf. Nos. 1486 and 1605), 4–4½ mm.—Malva sylv., M. Alc., M. mosch., Geran. pal., G. prat., G. pyren., G. Robert., Lotus corn. ♂ F+I+, Epil. angust., Lythr. Sal. ♀ F+I+, Valer. off., Inula Hel., Rudb. lacin., Achill. Millef., A. Ptarm., Doronic. Pardal., Silyb. Marian., Card. crisp., Lactuca perenn., Mulged. alpin., M. macrophyll., Crep. montan., Campan. rot., C. bonon., C. rapunculoides, C. Trach., C. persic., C. glom., C. latif. var. serot., C. pat., C. carpath., C. rhomb., Polemon. caerul., Conv. sep., Echium vulg., Veron. mont., Lavand. vera, Salv. prat. ♂ F±I+, S. off. ♂ F+I+, Scutell. altiss.
1423. *Cilissa haemorrhoidalis F.* (=Melitta haemorrhoidalis *F.*, cf. No. 1644), ♂ 3–4 mm.—Malva sylv., M. Alc., Lotus corn. ♂ F+I+, Scab. ochrol.,

Campan. rot., C. bonon., C. rapunculoides, C. Trach., C. pat., Prun. vulg. F±I+ and F+I+.

1424. *C. leporina Pz.* (=Melitta leporina *Pz.*, cf. Nos. 1426 and 1646), 3½ mm.—Ononis spin. ♀ F+I+, O. rep., Medic. sat. ♀ and ♂ F+I+, M. falc., Trif. rep. ♀ and ♂ F+I+, T. hybr. ♂ F+I+, T. prat. ♂ F±I+, T. arv. ♀ F+I+, Lotus corn. ♀ F+I+, Cirs. arv., Jas. mont., Atropa Bell., Thym. Serp.

1425. * *C. melanura Nyl.* (=Melitta melanura *Nyl.*, cf. No. 1647), 3–4 mm.—Hyper. perfor., Lythr. Sal. ♀ and ♂ F+I+, Thrinc. hirt.

1426. *C. tricincta K.* (=Melitta leporina *Pz.*, cf. Nos. 1424 and 1646), 3½ mm.—Medic. med., Dorycnium hirs., Lotus corn. ♀ F+I+, Sedum acre, Achill. Millef., Card. acanth.

1427. Coelioxys acuminata *Nyl.*—Rubus caes., Knaut. arv., Helianth. an., Calend. off., Carl. vulg., Leont. aut., Jas. mont.

1428. *C. acuta Nyl.* (=C. quadridentata *L.*, cf. Nos. 1432 and 1439).—Campan. glom.

1429. C. afra *Lep.*—Stach. recta.

1430. C. aurolimbata *Foerst.*—Dorycn. herbac., Thym. Cham., Stach. recta, Marrub. candidiss., Leon. Marrub., Teucr. Cham.

1431. C. brevis *Ev.*—Jas. mont.

1432. *C. conica L.* (=P. quadridentata *L.*, cf. Nos. 1428 and 1439).—Melilot. off. F+I+, M. albus F+I+, Centaur. nigr., Teucr. Scorod.

1433. C. conoidea *Ill.* (=*C. punctata Lep.*, cf. Nos. 1438 and 1445).—Malva sylv., Geran. prat., Onobr. viciif., Rubus frutic., Knaut. arv., Inula hirt., Cirs. arv., C. lanceol., Card. crisp., Onopord. Acanth., Centaur. Scab., C. rhen., Hierac. umbell., Jas. mont., Asclep. syr. F+I+, Anchus. off., Echium vulg., Lavand. vera, Origan. vulg., Stach. recta F+I+, Teucr. Cham.

1434. C. elongata *Lep.* (cf. Nos. 1442 and 1443).—Malva sylv., Geran. prat., G. phaeum, G. rubell., Melilot. altiss. F+I+, M. off. F+I+, M. albus F+I+, Lotus corn. F+I+, Rubus frutic., R. Id., Sedum refl., Aster chin., Rudb. lacin., Ligul. specios., Senec. Jacob., Stach. recta.

1435. C. mandibularis *Nyl.*—Lotus corn. ♀ F+I+, Knaut. arv., Jas. mont.

1436. *C. octodentata Lep.* (=C. rufocaudata *Sm.*, cf. No. 1441).—Melilot. off. F+I+, Knaut. arv., Achill. Millef., Echium vulg.

1437. C. polycentris *Foerst.*—Marrub. peregr.

1438. *C. punctata Lep.* (=C. conoidea *Ill.*, cf. Nos. 1433 and 1445).—Anchusa off., Echium vulg., Marrub. vulg. F+I+.

1439. C. quadridentata *L.* (cf. Nos. 1428 and 1432).—Geran. prat., Melilot. altiss. ♂ F+I+, Trif. prat. ♂ F+I+, T. arv. ♀ F+I+, Lotus corn. ♀ F+I+, Lathyr. mont. ♀ F+I+, Rubus Id., Knaut. arv., Carl. vulg., Centaur. mont., Jas. mont., Echium vulg., Thym. Serp., Stach. recta.

1440. C. rufescens *Lep.* (cf. No. 1444).—Malva sylv., Geran. pal., G. prat., G. Robert., Medic. sat. ♂ F+I+, Trif. rep. ♀ and ♂ F+I+, Lotus corn. ♀ F+I+, Vicia Cracca ♀ F+I+, Rubus frutic., R. caes., R. Id., Liban. mont., Knaut. arv., Inula Hel., Sonchus asp., Hierac. muror., Echium vulg., Verbasc. nigr., Lavand. vera, Salv. verticill. ♀ and ♂ F+I+, Origan. vulg., Stach. germ. var. interm., S. lanata, Leon. Card.

1441. C. rufocaudata *Sm.* (cf. No. 1436).—Res. odor., Melilot. altiss. F+I+, Stach. recta.

1442. *C. simplex Nyl.* (=C. elongata *Lep.*, cf. Nos. 1434 and 1443), 4½ mm.—Bryon. dioica ♀ F+I+, Aster chin., Hierac. umbell., Jas. mont., Echium vulg.

1443. *C. tricuspidata Foerst.* (=C. elongata *Lep.*, cf. Nos. 1434 and 1442).—Echium vulg.

1444. C. umbrina *Sm.* (=C. rufescens *Lep.*, cf. No. 1440).—Onobr. viciif., Echium vulg.

1445. C. vectis *Curt.* (=C. conoidea *Ill.*, cf. Nos. 1433 and 1438).—Marrub. vulg. F+I+.

1446. C. sp.—Melilot. albus F+I+, Lotus corn. F+I+, Jas. mont., Asclep. syr., Polemon. coerul., Thym. Serp.

1447. Colletes balteatus *Nyl.*—Trif. rep. F+I+, Campan. persic.

1448. C. cunicularis *L.* 3½–4 mm.—Brass. oler., Potent. Anser., P. sylv., Tarax. off., Vacc. uligin., Armer. elong., Empetr. nigr., Salix cin., S. Capr., S. aurit., S. alba, S. fragil., S. vimin., S. rep.

1449. C. daviesanus *K.*, ♀ 2½–3 mm.—Malach. aquat., Genista tinct. F+I+, Trif.

med., Oenoth. bien. ♀ F+I+, Aegop. Podagr., Peuced. Oreos., Anthr. sylv., Achill. Millef., A. Ptarm., Anthem. arv., A. tinct., Matric. Cham., M. inod., Tanac. vulg., Chrys. Leuc., Leont. aut., Hypoch. radic., Narth. ossifr.

1450. C. fodiens *Fourcr.* (K.), 2½ mm.—Malva sylv., Melilot. albus F+I+, Trif. prat. ♀ F+I+, Lotus corn. ♀ F+I+, Peuced. Oreos., Achill. Millef., A. Ptarm., Tanac. vulg., Senec. Jacob., Thym. Cham.
1451. C. hylaeiformis *Ev.*—Thym. Serp.
1452. C. impunctatus *Nyl.*—Achill. Millef., Euphras. off.
1453. C. lacunatus *Dours.*—Res. lutea, Cist. monspel., Paliurus acul., Dorycn. herbac., Vicia villosa var. varia, Thym. Cham.
1454. C. marginatus (L.) *Sm.*—Trif. rep. F+I+, T. arv. ♀ and ♂ F+I+, Rubus caes., Achill. Millef., Anthem. tinct., Tanac. vulg., Jas. mont., Euphras. off.
1455. C. nasutus *Sm.*—Trif. rep. F+I+, Anchusa off., Echium vulg.
1456. C. niveofasciatus *Dours.*—Res. lutea, Thym. Cham., T. dalm.
1457. C. picistigma *Thoms.*—Rubus caes., Achill. Millef., Matric. Cham., Tanac. vulg., Senec. Jacob.
1458. C. punctatus *Mocs.*—Nigella arv.
1459. C. succinctus *L.*—Call. vulg.
1460. C. sp.—Medic. sat. F+I+.
1461. Crocisa histrio *F.*—Knaut. arv.
1462. C. major *Mor.*—Sedum acre, Centaur. Calcitr., C. solstit., Conv. cantabr., Echium vulg., Lycium vulg.
1463. C. ramosa *Lep.*—Echium vulg., Lycium vulg.
1464. C. scutellaris *F.*—Dipsac. sylv., Lobel. Erin., Lycium vulg., Lavand. vera, Lam. alb. F+I+, Ball. nigr. ♀ F+I+, Ajug. rept. F+I+
1465. C. truncata *Pér.*—Echium vulg., Lycium vulg.
1466. Dasypoda argentata *Pz.*—Knaut. arv., Jas. mont.
1467. D. argentata *Pz.* var. braccata *Ev.*—Scab. Columb. var. ochroleuca.
1468. *D. hirtipes F.* (=D. plumipes *Pz.*, cf. No. 1469), 5 mm.—Knaut. arv., Cirs. arv., Card. acanth., Rhapont. pulch., Centaur. Jac., Cent. rhen., Cichor. Int., Thrinc. hirt., Leont. aut., Picr. hierac., Hypoch. radic., Tarax off., Crep. bien., C. vir., Hierac. Pilos., H. umbell., Jas. mont.
1469. D. plumipes *Pz.* (cf. No. 1468).—Knaut. arv., Leont. aut., Picr. hierac., Hypoch. radic., Chondrilla junc., Sonchus arv., S. asp., Crep. vir., Hierac. Pilosel., H. muror., H. umbell., Jas. mont., Armer. elong.
1470. D. thomsoni *Schlett.*—Knaut. arv.
1471. Dioxys tridentata *Nyl.*—Teucr. Cham.
1472. *Diphysis serratulae Pz.* (=Trachusa serratulae *Pz.*, cf. No. 1869), ♁ 7–8 mm.—Viola tric. arv. F+I+, Hyper. perfor., Genista tinct. F+I+, Cytis. sagitt., Trif. prat. ♀ F+I+, T. arv. ♁ F+I+, Lotus corn. ♀ and ♁ F+I+, Vicia Cracca ♀ F+I+, Lathyr. prat. ♀ F+I+, Rubus frutic., Knaut. arv., Leont. aut., Hypoch. radic., Hierac. Pilos., Jas. mont., Call. vulg., Echium vulg.
1473. Dufourea alpina *Mor.*—Phyteuma Scheuchz.
1474. D. halictula *Nyl.* (cf. No. 1842).—Senec. Jacob., Hierac. nemor., Jas. mont.
1475. D. vulgaris *Schenck.*—Ranunc. Flamm., Potent. sylv., Thrinc. hirt., Leont. aut., Picr. hierac., Hypoch. radic., H. glabra, Crep. bien., C. vir., C. tector., Hierac. Pilos., H. muror., Campan. rot., Jas. mont., Call. vulg., Digit. ambigua.
1476. Epeoloides caecutiens. *F.*—Lythr. Sal. F+I+, Ball. nigr.
1477. Epeolus fasciatus *Friese* (=*E. transitorius Friese*).—Nigella arv.
1478. E. productus *Thoms.*—Tanac. vulg., Thym. Serp.
1479. E. tristis *Sm.* (teste Schletterer) (=*E. scalaris Ill.*).—Paliurus acul.
1480. E. tristis *Sm.*—Thym. Serp.
1481. E. variegatus *L.*—Trif. arv. F+I+, Knaut. arv., Succ. prat., Inula Hel., Inul. brit., Tanac. vulg., Senec. Jacob., S. erucif., Leont. aut., Hierac. Pilos., Jas. mont., Call. vulg., Anchusa off., Euphras. off., Origan. vulg., Thym. Serp.
1482. Eriades campanularum *K.* (cf. No. 1419).—Papaver somnif., Paliurus acul., Heracl. Sphond., Anthr. sylv., Campan rot., C. Rapunculus, C. glom., Jas. mont.
1483. E. crenulatus *Nyl.*—Centaur. arenar.
1484. E. florisomnis *L.* (cf. Nos. 1420 and 1421), ♀ 4½ mm.—Ranunc. acris, R. rep., R. bulb., R. lanug., Brass. Rapa, B. Nap., Sinap. arv., Malva sylv., Rubus

Id., Crat. Oxyac., Hypoch. radic., Tarax. off., Hierac. Pilos., Veron. verna, Salv. verticill. F+I+, Lam. alb.

1485. E. grandis *Nyl.*—Leont. hast.

1486. E. nigricornis *Nyl.* (cf. Nos. 1422 and 1605).—Ranunc. rep., R. acris, R. bulb., Sisymbr. off., Sinap. arv., Malva sylv., Geran. Robert., Epil. angust., Lythr. Sal. F+I+, Heracl. Sphond., Knaut. arv., Tanac. vulg., Senec. Jacob., Cichor. Intyb., Campan. rot., C. Trach., C. persic., C. pat., Jas. mont., Echium vulg.

1487. E. truncorum *L.* (cf. Nos. 1606 and 1870).—Papaver somnif., Malva sylv., Geran. prat., Melilot. altiss., Rubus frutic., R. Id., Oenanthe fist., Knaut. arv., Scab. luc., Bellis per., Pulic. dysent., Helen. autumn., H. decur., Helianth. multifl., Heliops. patul., Rudb. lacin., Helichrys ang., Achill. Millef., A. Ptarm., Anthem. arv., A. tinct., Matric. Cham., Tanac. vulg., T. parthenif., Chrys. Leuc., Doronic. Pardal., D. austriac., Arnica Chamiss., Senec. vulg., S. Doronic., S. nemor., S. Jacob., Cirs. arv., C. pal., Card. acanth., Leont. aut., L. asper., Picr. hierac., Hypoch. radic., Crep. bien., C. vir., C. Tector., Hierac. bupleur., Campan. pat., Ligustr. vulg., Verbasc. nigr.

Eucera. Species marked † belong to the subgenus Macrocera.

1488. Eucera albofasciata *Friese.*—Rindera tetrasp.

1489. † E. alternans *Brull.*—Dorycn. herbac., Trif. prat., Stach. recta, Marrub. vulg. F+I+.

1490. †* E. armenica *Mor.*—Salv. sylv. F+I+.

1491. † *E. basalis Mor.* (=E. salicariae *Lep.*, cf. Nos. 1516 and 1868).—Lythr. Sal. F+I+.

1492. E. bibalteata *Dours.*—Anchusa off.

1493. E. caspica *Mor.*—Coron. Emer., Rosm. off., Muscari racemos.

1494. E. caspica *Mor.* var. perezi *Mocs.*—Muscari racemos.

1495. E. chrysopyga *Pér.*—Anchusa off., Nonn. pulla.

1496. E. cinerea *Lep.*—Hippocrep. com., Knaut. arv.

1497. E. clypeata *Erichs.*—Raphan. sat., Dorycn. herbac., Vinca maj., Nonn. pulla.

1498. E. curvitarsis *Mocs.*—Anchusa off.

1499. E. dalmatica *Lep.*—Echium vulg., E. altiss.

1500. †* E. dentata *Klug.*—Lythr. Sal. ♂ F+I+, Centaur. aren.

1501. E. difficilis (*Duf.*) *Pér.*—Geran. molle, Trif. rep. F+I+, T. prat. ♀ and ♂ F+I+, Lotus corn. ♀ and ♂ F+I+, Vicia Cracca ♀ F+I+, V. sep. ♀ F+I+, Lathyr. prat. ♀ and ♂ F+I+, Tarax. off., Crep. bien., Nonn. pulla, Teucr. Scorod. F+I+.

1502. † E. graja *Ev.*—Centaur. Biberst.

1503. E. hispana *Lep.*—Dorycn. hirs., Salv. Bertol., Marrub. candidiss., Teucr. flavum.

1504. † E. hungarica *Friese.*—Medic. sat., Centaur. Cyan., Anchusa off., Nonn. pulla.

1505. E. interrupta *Baer.*—Coron. Fl.-cuc., Dorycn. hirs., D. herbac., Lotus corn., Coron. Emer., Vicia hybr., Rubus caes., Helichrys. ang., Anchusa off., Nonn. pulla, Salv. Bertol., Thym. Cham., T. dalm., Stach. recta, Ajug. genev., Teucr. Cham.

1506. E. longicornis *L.*, 10–12 mm.—Papav. Rhoeas, Corydal. lutea, Cheiranth. Cheiri, Caps. Bursa-past., Raphan. sat., Res. lutea, Polyg. com., Coron. Fl.-cuc., Saroth. scop. F+I+, Medic. sat. ♀ F+I+, Trif. prat. ♀ and ♂ F+I+, T. incarn. ♀ and ♂ F+I+, T. alp. ♀ and ♂ F+I+, Anthyll. Vuln. ♀ F+I+, Lotus corn. ♀ and ♂ F+I+, Oxytropis pil., Astrag. Onobr., Coron. Emer., Onobr. viciif., Vicia Cracca ♀ and ♂ F+I+, V. hybr., V. vill. var. varia, V. sep. ♀ and ♂ F+I+, V. sat. ♀ and ♂ F+I+, Pisum sat. F+I+, Lathyr. prat. ♀ F+I+, L. latif., L. cirrhosus, Phaseolus multifl. ? F+I+, Crat. Oxyac., Symphoric. racem. ♂ F+I+, Syring. vulg., Vinca maj., Anchusa off., Symph. off., Echium vulg., Lycium vulg., Veron. mont., Salv. prat. ♀ and ♂ F+I+, S. off. ♀ and ♂ F+I+, S. Bertol., Thym. dalm., Lam. alb. ♂ F+I+, L. mac. ♂ F+I+, L. purp. ♂ F+I+, Ajug. rept. F+I+, A. genev., Teucr. Scorod., Plantag. med., Orchis latif. F+I+, O. Morio F+I+, Scilla marit.

1507. † E. Malvae *Rossi.*—Malva Alcea, Conv. sep.

1508. E. nigrifacies *Lep.*—Onopord. Acanth.

1509. E. nitidiventris *Mocs.*—Borago off., Anchusa off., Nonn. pulla.

1510. *E. paradoxa Mocs.* (=E. seminuda *Brull.*, cf. No. 1518).—Anchusa off.
1511. E. parvicornis *Mocs.*—Nonn. pulla.
1512. E. parvula *Friese.*—Trif. nigresc., Vicia vill. var. varia, Thym. Cham.
1513. † E. pollinosa *Lep.* (cf. No. 1867).—Knaut. arv., Scab. ochrol., Centaur. rhen.
1514. † E. ruficollis *Brull.* (cf. No. 1609).—Dorycn. herbac., Vicia villosa var. varia, Salv. off. F+I+, S. Bertol., Thym. Cham.
1515. † E. ruficornis *F.*—Melilot. albus F+I+.
1516. †* E. salicariae *Lep.* (cf. Nos. 1491 and 1868).—Melilot. albus F+I+, Lythrum Sal. ♀ and ♂ F+I+.
1517. † E. scabiosae *Mocs.*—Scab. ochrol.
1518. E. seminuda *Brullé.* (cf. No. 1510).—Trif. prat. ♀ F+I+, Anchusa off.
1519. E. semistrigosa *Dours.*—Anchusa off.
1520. † E. similis *Lep.*—Echium vulg., Salv. Sclar.
1521. † E. spectabilis *Mor.*—Echium vulg., Salv. Sclar.
1522. † E. tricincta *Er.*—Anchusa off., Echium vulg., Salv. sylv. F+I+.
1523. † E. velutina *Mor.*—Rindera tretrasp.
1524. E. spec.—Lathyr. sylv. F+I+.
1525. Halictoides dentiventris *Nyl.*, 3–3½ mm.—Dryas octopet., Hierac. Pilos., Campan. rot., C. rapunculoides, C. Trach., C. persic., C. pat.
1526. H. inermis *Nyl.*—Leont. aut., Campan. rot., Jas. mont., Call. vulg.
1527. H. paradoxus *Mor.*—Phyteuma Scheuchz., Euphras. Rostkov.
1528. *Halictus albidulus Schenck* (=H. tomentosus *Schenck*, cf. No. 1595).—Ranunc. acris, R. rep., R. bulb.
1529. H. albipes *F.* (cf. No. 1535).—Adon. vern., Ranunc. acris, R. rep., R. bulb., R. auric., R. Fic., Brass. Rapa, Stell. Holost., S. med., Malva sylv., Geran. pal., G. prat., G. phaeum, Genista tinct. F+I+, Onobr. viciif., Prunus spin., Rosa pomif., Rubus frutic., Fragaria vesca, Potent. verna, Sedum album, Ribes Gross., Aegop. Podagr., Carum Car., Foenic. vulg., Heracl. Sphond., Dauc. Car., Knaut. arv., Chrysoc. Linos., Bellis per., Pulic. dysent., Achill. Millef., Tanac. vulg., Chrys. Leuc., Senec. Jac., Cirs. arv., Card. crisp., C. acanth., Centaur. Jac., Cichor. Int., Leont. hast., Picr. hierac., Tarax. off., Lactuca mural., Crepis bien., Hierac. muror., Campan. rot., C. rapunculoides, Jas. mont., Syring. vulg., Echium vulg., Linar. Cymb., Veron. off., V. arv., V. hederif., Salv. verticill. ♀ and ♂ F+I+, Origan. vulg., Lam. purp., Stach. recta, Ball. nigr., Prim. veris, Plantag. med., Polygon. Pers., Salix cin., S. Capr., S. aurit., Gagea arv., Antheric. ramos., Hyac. orient., Narth. ossifr.
1530. H. albipes *F.* var. affinis *Schenck.*—Vit. vinif., Rubus frutic.
1531. *H. alternans Ill.* (=H. scabiosae *Rossi* ? cf. No. 1582).—Helianth. an.
1532. H. brevicornis *Schenck*, ♀ 3½ mm.—Berter. incana, Leont. aut., Hypoch. radic., Salix alba, S. fragil.
1533. H. calceatus *Scop.* ♀ 3½ mm. (cf. No. 1541).—Clemat. Vit., Ranunc. illyr., Papav. hybrid., Cheiranth. Cheiri, Nasturt. Lippic., Arab. aren., Sisymbr. off., Brass. oler., B. Rapa, B. Nap., Eroph. verna, Cak. marit., Raphan. sat., Res. lutea, Helianth. vulg., Cist. monspel., Viola odor., Cerast. glomer., Geran. molle, Erod. cicut., E. malacoid., Paliur. acul., Melilot. altiss. F+I+, Lotus corn. ♀ F+I+, Rubus frutic., R. Id., Fragaria vesca, Potent. cinerea, P. opaca, Cydon. jap., Pyrus Malus, Epil. angust., Lythr. Sal. (F+I+), Ribes Gross., Heracl. Sphond., Tordyl. apul., Knaut. arv., Succ. prat., Scab. gram., Bellis per., Solidag. Virgaur., Anthem. arv., Senec. Jacob., Calend. arv., Card. nut., Centaur. solstit., C. nigresc., Cichor. Int., Thrinc. hirt., Leont. aut., Tragop. prat., Urosperm. Dalechamp., Hypoch. radic., Tarax. off., Hierac. Pilosel., Jas. mont., Vacc. Myrt., Call. vulg., Veron. Cham., V. Beccab., V. arv., Satureia mont., Thym. Serp., Lam. purp., Stach. arv., Ajug. genev., Lysim. vulg., Euphorb. heliosc., Salix Capr., S. vimin., S. rep.
1534. H. calceatus *Scop.* var. elegans *Lep.*—Crat. Oxyac., Tarax. off., Salix alba, S. fragil.
1535. *H. calceatus Scop. var. obovatus K.* (=H. albipes *F.*, cf. No. 1529).—Cist. vill., Dorycn. herbac., Laur. nob.
1536. *H. canescens Schenck* (=H. lineolatus *Lep.*, cf. Nos. 1552 and 1598).—Eric. Tetr.
1537. *H. carinaeventris Mor.* (=H. cariniventris *Mor.*).—Thym. Serp.
1538. H. cephalicus *Mor.* (cf. No. 1597, certainly=H. gemmeus *Dours.*).—Conv. arv.

1539. H. clypearis *Schenck*.—Ball. nigr.
1540. H. costulatus *Kriechb*.—Foenic. vulg., Campan. Trach.
1541. *H. cylindricus F.* (=H. calceatus *Scop*., cf. No. 1533), 3–4 mm.—Thalictr. aquilegif., Pulsat. vulg. F+I+, Anem. nemor., Adon. vern., Ranunc. Flamm., R. acris, R. rep., R. bulb., R. auric., R. Fic., Papaver Rhoeas, P. somnif., Chelidon. majus, Arab. Turrita, Cardam. prat., Brass. oler., Viola odor. F±I±, V. bifl., Stell. Holost., S. med., Cerast. arv., Malva sylv., M. Alc., Hyper. perfor., Linum usitat., Geran. pal., G. prat., G. sanguin., G. pyren., G. Robert., G. Ruthen., Erod. cicut., Impat. Noli-tang. ♀ (F+I+), Genista angl. ♀ F+I+, Trif. prat. ♀ (F+I+), F±I+, Amygd. comm., Prunus spin., Rubus frutic., Potent. rept., P. verna, Crat. Oxyac., Lythr. Sal. ♀ (F+I+), Bryon. dioica ♀ F+I+, Ribes Gross., Heuch. cylind., Eryng. camp., Aegop. Podagr., Pastin. sat., Heracl. Sphond., Symphoric. racem. ♂ F+I+, Asper. odor., Gal. ver., Cephal. rad., Knaut. arv., Succ. prat., Scab. ochrol., Aster prenanth., Biotia corymb., Chrysoc. Linos., Bellis per., Diplopapp. amygd., Solidag. canad., S. fragr., S. glab., S. livida, S. Ridel., Pulic. dysent., Helen. autumn., Coreops. auric., Achill. Millef., A. Ptarm., Anthem. tinct., Matric. inod., Chrys. Leuc., Doronic. Austriac., D. macroph., Senec. nemor., S. macroph., S. Jacob., Echinops sphaeroc., Cirs. arv., C. lanceol., C. pal., Card. crisp., C. acanth., C. nut., Onopord. Acanth., Lappa min., Carl. acaul., C. vulg., Centaur. Jac., C. micropt., Cichor. Int., Thrinc. hirt., Leont. aut., L. hast., Picr. hierac., Tragop. floccos., Scorzon. humil., S. parvifl., Hypoch. radic., H. glabra, Tarax. off., Crep. bien., C. vir., Hierac. Pilos., H. vulgat., H. umbell., H. brevifol., H. crinit., H. viros., Campan. Trach., Jas. mont., Vacc. uligin., Call. vulg., Asclep. Syr. F+I+, Conv. sep., Pulm. off., Echium vulg., Caryolopha semperv., Atropa Bell., Hyosc. nig., Physochlaena orient., Verbasc. Thaps., Scroph. nod., S. aquat., Linar. Cymb., Digit. purp., Veron. Cham., Plectranth. glaucocalyx, Mentha aquat., Origan. vulg., Thym. Serp., Lam. purp. F±I±, L. incis., Physostegia virgin., Verben. off., Prim. veris, Plantag. med., Rumex obtusif., Polygon. amph., Daphne Mez., Salix cin., S. Capr., S. aurit., Tulipa Didieri, Gagea arv., Allium Cepa, Narth. ossifr., Uvularia flava.
1542. H. fasciatellus *Schenck*.—Ranunc. illyr., Nasturt. lippic., Brass. oler., Bunias Erucago, Cist. vill., Potent. hirta, Anthem. arv., Hierac. Pilos., Thym. Cham., T. dalm., Muscari racemos.
1543. H. fasciatus *Nyl*., ♀ 3½ mm.—Jas. mont.
1544. *H. flavipes F.* (=H. tumulorum *L*., cf. Nos. 1583 and 1596).—Ranunc. Flamm., R. acris, R. rep., R. bulb., R. lanugin., Papav. Rhoeas, Arab. aren., Brass. oler., B. Rapa, B. Nap., Teesdal. rudic., Raphan. Raph., Res. odor., Stellar. Holost., S. med., Malva sylv., Geran. pal., Genista angl. ♀ F+I+, Medic. lupul. ♀ F+I+, Trif. prat. ♀ F+I+, T. arv. ♀ F+I+, T. agrar. ♀ F+I+, T. procumb. ♀ F+I+, Lotus corn. ♀ F+I+, Ornith. perpus. ♀ F+I+, Onobr. viciif., O. hirs. ♂ F+I+, Prunus spin., Rubus frutic., Potent. Anser., P. rept., P. verna, Spir. sorbif., S. salicif., S. ulmif., Epil. angust., Sedum album, Ribes Gross., Heracl. Sphond., Chrysoc. Linos., Solidag. Virgaur., Senec. Jacob., Cirs. arv., Card. crisp., Cichor. Int., Thrinc. hirt., Leont. aut., Hypoch. radic., Tarax. off., Sonchus arv., Crepis bien., Hierac. Pilos., H. muror., Campan. rot., C. bonon., Jas. mont., Vacc. Myrt., V. uligin., Gent. Pneum., Scroph. nod. ♂ F+I+, Veron. Cham., V. Beccab., Mentha sylv., Origan. vulg., Thym. Serp., Nepeta nuda, Verben. off., Polygon. Convolv., Euphorb. Cypar., Salix cin., S. Capr., S. aurit., S. alba, S. fragil., S. vimin., S. rep., Gagea arv.
1545. *H. fulvicornis K.* (=H. levis *K*., cf. No. 1551).—Knaut. arv.
1546. H. interruptus *Pz*.—Brass. Rapa, Lepid. Draba, Res. lutea, Cist. vill., C. salviif., Paliurus acul., Trif. prat. ♀ F+I+, T. nigresc., Vicia hybr., Rosa pomif., Potent. cinerea, P. opaca, Sedum album, Bupleur. falcat., Heracl. Sphond., Dauc. Car., Achill. Millef., A. Ptarm., Echinops sphaeroc., Card. acanth., Centaur. Jac., Cichor. Int., Thym. Serp., T. dalm.
1547. H. leucopus *K*.—Ranunc. acris, R. rep., R. bulb., Papaver Rhoeas, P. somnif., Arab. aren., Hesper. matron., Brass. Rapa, B. Nap., Stell. med., Genista angl., Lotus corn. F±I±, Rubus frutic., R. Id., Fragaria vesca, Potent. arg., P. verna, Lythr. Sal. ♀ (F+I+), Heracl. Sphond., Weigel. ros. ? F+I+, Succ. prat., Eupat. can., Inula Hel., Centaur. Scab., Leont. aut., Tarax. off.,

Crep. bien., Hierac. Pilos., Atropa Bell., Verbasc. Lychn., Veron. Cham., V. hederif., Salv. verticill. ♀ F+I+, Lam. purp. F±I±, Prun. vulg. (F+I+), Daphne Mez., Butom. umb., Gagea fascic., Allium rot.

1548. H. leucozonius *Schr.*, 4 mm.—Ranunc. acris, R. rep., R. bulb., Aquil. vulg. F+I+, Sinap. arv., Cerast. arv., Geran. prat., G. striatum, Erod. cicut., Paliur. acul., Lotus corn. ♀ ? F+I+, Prunus Armen., Rubus frutic., Potent. rept., Oenoth. bien. × O. muric., Philad. coron. F±I±, Lythr. Sal. ♀ and ♂ (F+I+), Peuced. Cerv., Heracl. Sphond., Knaut. arv., Succ. prat., Aster. brumal., Bellis per., Solidag. Virgaur., Silph. Asterisc., Helichrys. ang., Achill. Millef., A. Ptarm., Chrys. Leuc., Doronic. austriac., D. plantag., Cirs. lanceol., Card. crisp., C. acanth., C. nut., Onopord. Acanth., Centaur. Jac., C. Calcitr., C. rhen., Lamps. com., Cichor. Int., Thrinc. hirt., Leont. aut., L. hast., Picr. hierac., Hypoch. radic., Tarax. off., Crep. bien., C. vir., C. palud., Hierac. Pilos., H. muror., H. umbell., H. australe, H. crinit., Campan. rapunculoides, Jas. mont., Call. vulg., Conv. arv., Veron. Cham., Salv. verticill. F+I+, Thym. Cham., T. dalm., Clinop. vulg., Rosmar. off., Lam. purp., Stach. arv., Orchis latif. F+I+.

1549. H. leucozonius *Schr.* var. nigrotibialis *D.-T.*—Hedys. coron.

1550. H. levigatus *K.*—Cheiranth. Cheiri, Nasturt. lippic., Myagr. perfol., Cist. vill., Trif. nigresc., Lotus corn. ♀ ? F+I+, Potent. cinerea, P. opaca, Tordyl. apul., Tanac. Parth., Senec. Jacob., Card. nut., Picr. hierac., Tarax. off., Campan. pat., Thym. dalm., Rosmar. off., Lam. alb. ♀ F+I+.

1551. H. levis *K.* (cf. No. 1545), ♀ 1½–2 mm.—Brass. oler., Cochlear. Armorac., Rubus frutic., R. Id., Crat. Oxyac., Pyrus Malus, Petrosel. Sat., Dauc. Car., Leont. aut., Picr. hierac., Tarax. off., Crep. aurea, Jas. mont., Salix Capr., S. alba, S. fragil.

1552. H. lineolatus *Lep.* (cf. Nos. 1536 and 1598).—Eric. Tetr.

1553. Halictus longulus *Sm.*—Ranunc. acris, R. rep., R. bulb., Papaver Rhoeas, Geran. pal., Eryng. camp., Silaus prat., Valerianel. aur., Pulic. dysent., Senec. Jacob., Cirs. arv., Card. acanth., Lappa min., Centaur. Jac., Cichor. Int., Leont. aut., Picr. hierac., Tarax. off., Crep. bien., Hierac. Pilosel., Phyteuma spic., Conv. arv., Veron. Cham., Mentha aquat., Salv. verticill. F+I+, Antheric. ramos.

1554. H. lucidulus *Schenck.*—Teesdal. nudicaul., Lepid. sat., Aren. serpyllif., Geran. prat., G. pusill., Rubus frutic., R. Id., Fragaria vesca, Anthem. arv., Card. acanth., Centaur. Jac., Cichor. Int., Tarax. off., Jas. mont., Veron. hederif., Nepeta Glech. F±I±.

1555. H. lucidus *Schenck.*—Ranunc. Fic., Senec. nemor., Crep. vir.

1556. *H. lugubris K.* (=H. laevigatus *K.*).—Ranunc. acris, R. rep., R. bulb., Onobr. viciif., Heracl. Sphond., Knaut. arv., Chrys. Leuc., Thrinc. hirt., Hypoch. radic., Sonchus arv., Crepis bien., Lam. mac., Verben. off.

1557. H. maculatus *Sm.*—Ranunc. acris, R. rep., R. bulbos., Papav. Rhoeas, Nasturt. off., Malva sylv., Geran. prat., G. sanguin., G. pyren., Dorycn. herbac., Trif. rep. F+I+, Prunus avium, Potent. rept., P. arg., P. verna, Lythr. Sal. F+I+, Carum Car., Orlaya grand., Myrrhis odor., Pulic. dysent., Achill. Millef., A. Ptarm., Anthem. tinct., Tanac. vulg., T. corymb., Chrys. Leuc., Senec. Jacob., Echinops sphaeroc., Cirs. arv., C. lanceol., Card. acanth., Onopord. Acanth., Centaur. Jac., C. Scab., Thrinc. hirt., Leont. aut., Picr. hierac., Tarax. off., Crep. bien., Hierac. Pilos., Jas. mont., Mentha aquat., Salix fragil., Antheric. ramos., Scilla marit., Allium rot.

1558. H. major *Nyl.*—Vicia sep., Pimpin. magn. var. ros., Veron. Cham., V. spic., Calam. off., Teucr. Cham.

1559. H. malachurus *K.*—Clemat. Vitalba, Sinap. arv., Lepid. Draba, Caps. Bursa-past., Raph. sat., Sperg. arv., Hyper. perfor., Trif. prat. ♀ F+I+, Rubus frutic., Potent. cinerea, P. opaca, Epil. angust., Saxifr. gran., Symphoric. racem. ♂ F+I+, Valer. off., Knaut. arv., Bellis per., Senec. Jacob., Cirs. lanceol., Card. nut., Centaur. Jac., Leont. aut., Hypoch. radic., Tarax. off., Crep. tector., Phyteuma nigr., Jas. mont., Conv. arv., Atropa Bell., Veron. mont., V. arv., Thym. Cham., T. dalm., Nepeta nuda, Salix cin., S. Capr., S. aurit., Narth. ossifr.

1560. H. minutissimus *K.*—Batrach. aquat., Trollius europ., Medic. lupul., Epil. Fleisch., Lythr. Sal. ♀ (F+I+), Sedum Spectab., Saxifr. gran., Bellis per., Echinops Sphaeroc., Leont. aut., Tarax. off., Verbasc. Lychn., Euphras. off., Daphne Mez., Sisyrinch. anceps.

1561. *H. minutulus Schenck* (= H. nitidus *Schenck*, cf. No. 1568).—Tanac. vulg.
1562. H. minutus *K.* (= H. minutus *Schr.*).—Ranunc. Fic., Brass. oler., Lepid. Draba, Cist. vill., C. monspel., Lotus corn. ♀ F±I+, Rubus caes., R. Id., Aegop. Podagr., Heracl. Sphond., Tordyl. apul., Anthr. sylv., Cirs. arv., Card. acanth., Centaur. Jac., Leont. aut., Picr. hierac., Tarax. off., Crep. vir., Hierac. Pilos., Lobel. Erin., Myosot. hisp., Veron. Cham., V. Beccab., Thym. dalm., Salix cin., S. Capr., S. aurit., S. alba, S. fragil., Gagea spath.
1563. H. morbillosus *Kriechb.*—Bunias Erucago, Dorycn. herbac., Melilot. altiss. F+I+, Rubus caes., Card. nut., Conv. arv., Anchusa off., Mentha aquat., Thym. Cham., T. dalm.
1564. H. morio *F.* 2½–3 mm.—Pulsat. vulg. F+I+, Adon. vern., Ranunc. acris, R. rep., R. bulb., R. Fic., Aconit. variegat., Cheiranth. Cheiri, Nasturt. lippic., Sisymbr. off., Brass. oler., Eroph. verna, Teesdal. nudicaul., Bunias Erucago, Raphan. Raph., Helianth. vulg., H. salicifol., Cist. monspel., Tunica Saxifr., Dianth. delt., Sapon. off., Cerast. brachypet., Malva Sylv., M. rotundif., Hyper. perfor., Vitis vinif., Medic. sat. ♀ F+I+, M. lupul., Prunus spin., Rubus frutic., Fragaria vesca, Potent. arg., P. verna, P. cinerea, P. opaca, Crat. Oxyac., Lythr. Sal. ♀ (F+I+), Bryon. dioica ♂ F+I+, B. alba F+I+, Sedum refl., S. altiss., Saxifr. gran., Petrosel. sat., Heracl. Sphond., Tordyl. apul., Symphoric. racem. F+I+, Bellis per., Achill. Millef., A. Ptarm., Tanac. vulg., Senec. vulg., S. Jacob., Echinops sphaeroc., Lamps. comm., Cichor. Int., Leont. aut., Tragop. prat., Hypoch. radic., Tarax. off., Sonchus asp., Crep. vir., Campan. Trach., Erythr. Cent., Conv. arv., Echium vulg., Antirrh. maj. F±I±, Veron. Cham., V. triph., Salv. prat. F±I+, Thym. Serp., Nepeta Glech. F+I+, Stach. arv., Prun. vulg. ? (F+I+), Teucr. Scorod. ↓, Verben. off., Lysim. vulg., Anag. arv., Salix alba, S. fragil.
1565. H. nanulus *Schenck.*—Potent. verna.
1566. H. nigerrimus *Schenck.*—Malva sylv.
1567. H. nitidiusculus *K.* ♀.—Clemat. Vitalba, Ranunc. acris, R. rep., R. bulb., R. Fic., Nasturt. sylvest., Brass. oler., B. Rapa, B. Nap., Alyss. mont., Schiever. podol., Eroph. verna, Teesdal. nudicaul., Lepid. sat., Raphanus Raphan., Stellar. Holost., S. med., Geran. pal., Erod. cicut., Trif. procumb. ♀ F+I+, Lathyr. mont. F±I±, Prunus spin., Geum coccin., Waldsteinia geoid., W. fragaroid., Potent. verna, Cydon. vulg., Sorbus Auc., Ribes alp., Saxifr. gran., Dauc. Car., Chrysoc. Linos., Bellis per., Anthem. arv., Tanac. vulg., Doronic. cauc., Senec. nebrod., S. Jacob., Cirs. arv., Card. acanth., Saussur. albesc., Centaur. Jac., Cichor. Int., Leont. aut., Picr. hierac., Hypoch. radic., H. glabra, Tarax. off., Hierac. Pilos., H. brevifol., H. viros., Conv. arv., Pulm. angustif., Echium vulg., Mertensia pulmonar., Scroph. nod. ♀ F+I+, Veron. Cham., V. hederif., Mentha aquat., Salv. prat. F±I+, S. verticill. ♀ F+I+, Nepeta Muss. ♀ F+I+, Lam. mac. forma hirs., Euphorb. nicaeens., Salix Capr., S. alba, S. fragil., Gagea stell.
1568. H. nitidus *Schenck.* (cf. No. 1561).—Geran. molle, Rosa can., Epil. angust., Ribes alp., Petrosel. Sat., Pulic dysent., Matric. Cham., Senec. Jacob., Cirs. arv., Tarax. off., Crep. bien., Hierac. Pilos., Echium vulg., Verbasc. Lychn., Veron. mont., Salv. prat. F±I+, S. verticill. ♀ F±I+, Origan. vulg., Verben. off., Daphne Mez., Gagea fascic.
1569. H. obscuratus *Mor.*—Muscari racemos.
1570. H. patellatus *Mor.*—Sil. viridifl., Melilot. altiss. F+I+, Coron. Emerus, Tanac. Parth., Anchusa off., Thym. dalm., Marrub. candidiss.
1571. H. pauxillus *Schenck.*—Rubus frutic., Eriger. canad., Tanac. vulg., Senec. Jacob., Antheric. ramos.
1572. H. politus *Schenck.*—Valerian. olit.
1573. H. pulchellus *Schenck* (= *Nomioides pulchellus Schenck*, cf. No. 1703).—Jas. mont., Stach. recta.
1574. H. punctatissimus *Schenck.*—Lathyr. mont. F±I±, Tarax. off., Crep. vir., Hierac. Pilos., Veron. Cham., V. arv.
1575. *H. punctulatus K.* (= H. villosulus *K.*, cf. No. 1599).—Brass. oler., Rubus Id., Sedum acre, Leont. aut., Hypoch. radic., Tarax. off., Crep. vir., C. tector., Hierac. Pilos., H. muror., Jas. mont., Call. vulg., Prun. vulg.
1576. H. quadricinctus *F.* (cf. No. 1579).—Cardam. prat., Myagr. perfol., Res. lutea, Malach. aquat., Medic. falc., Dorycn. herbac., Trif. arv. ♀ F+I+,

Rubus frutic., R. caes., Peuced. Cerv., Knaut. arv., Helichrys. ang., Achill. Millef., A. Ptarm., Echinops sphaeroc., Card. acanth., C. deflor., C. nut., Onopord. Acanth., Carl. acaul., C. vulg., Centaur. Jac., C. Scab., Cichor. Int., Picr. hierac., Hypoch. radic., Sonchus arv., Crepis bien., C. tector., C. palud., Hierac. Pilos., Campan. glom., Asclep. syr. F+I+, Origan. vulg., Marrub. candidiss., Ajug. genev., Verben. off.

1577. H. quadrinotatulus *Schenck.*—Rubus Id., Gnaph. lut.-alb., Leont. aut., Tarax. off., Verbasc. nigr., Salix alba, S. fragil., S. triand.

1578. H. quadrinotatus *K.*—Cist. vill., C. monspel., Potent. cinerea, P. opaca, Tordyl. apul., Kentroph. lanat., Card. acanth., Card. nut., Tarax. off., Spec. Spec.

1579. *H. quadristrigatus Ltr.* (=H. quadricinctus *F.*, cf. No. 1576).—Knaut. arv., Onopord. Acanth., Centaur. rhen., Tarax. off., Echium vulg., Salv. verticill. ♀ F+I+, Ajug. rept. F±I+.

1580. H. rubicundus *Chr.* 4–4½ mm.—Ranunc. acris, R. rep., R. bulb., Berb. vulg., Brass. oler., B. Rapa, B. Nap., Sinap. arv., Res. odor., Stell. Holost., Geran. pal., Genista tinct. F+I+, G. angl., Cytis. sagitt., Melilot. altiss. F+I+, M. off. F+I+, M. albus F+I+, Lotus corn. ♀ F+I+, Potent. Anser., Crat. Oxyac., Cydon. jap., Pyrus comm., Sorbus Auc., Ribes Gross., Angel. sylv., Succ. prat., Aster Lindl., Solidag. Virgaur., S. livida, Helen. autumn., Achill. Millef., A. Ptarm., Matric. inod., Tanac. vulg., Chrys. Leuc., Senec. Jacob., Echinops sphaeroc., Cirs. arv., Card. acanth., Centaur. Jac., Cichor. Int., Thrinc. hirt., Leont. aut., Picr. hierac., Hypoch. radic., Tarax. off., Sonchus arv., Crep. bien., C. tector., Hierac. Pilos., Jas. mont., Vacc. uligin., Call. vulg., Mentha aquat., Origan. vulg., Thym. Serp., Salix alba, S. fragil., S. triand., S. rep., Narth. ossifr.

1581. H. rufocinctus (*Sich.*) *Nyl.*—Tarax. off., Thym. dalm., Salix sp.

1582. H. scabiosae *Rossi.*—Cheiranth. Cheiri, Myagr. perfol., Cist. vill., C. monspel., Malva sylv., Dorycn. herbac., Rubus caes., Helichrys. ang., Card. nut., Centaur. Calcitr., Asclep. syr. F+I+, Conv. arv., Thym. Cham., T. dalm., Rosmar. off., Ajug. genev.

1583. *H. seladonius Fab.* (=H. tumulorum *L.*, cf. Nos. 1544 and 1596).—Tarax. off.

1584. H. semipunctulatus *Schenck.*—Potent. verna, Leont. aut.

1585. H. sexcinctus *F.*—Melilot. altiss. F+I+, Coron. Emerus., Lathyr. tuber., Foenic. vulg., Dipsac. sylv., Knaut. arv., Scab. Columb., Inula Hel., I. Conyza, Silyb. Marian., Card. nut., Onopord. Acanth., Centaur. Jac., C. Scab., Thrinc. hirt., Hypoch. radic., Tarax. off., Mulged. alpin., Crep. bien., Hierac. Pilos., Echium vulg., Thym. Cham., Nepeta Muss. F+I+, Lam. mac., Marrub. vulg. F+I+, M. candidiss.

1586. *H. sexmaculatus Schenck* (= a form of H. sexnotatulus *Nyl.*).—Veron. Cham.

1587. H. sexnotatulus *Nyl.*, ♀ 4 mm.—Brass. oler., B. Rapa, B. Nap., Crat. Oxyac., Cichor. Int., Leont. aut., Tarax. off., Call. vulg., Veron. Cham.

1588. H. sexnotatus *K.* ♂ 4 mm.—Clemat. recta, Thalict. aquilegif., Ranunc. acris, R. rep., R. bulb., Papav. Rhoeas, Chelid. majus, Arab. hirsuta, Sinap. arv., Res. lutea, Sil. acaul., Malach. aquat., Cerast. arv., Geran. pal., G. sanguin., Ruta graveol., Rhus Cotinus, Trif. rep. F+I+, T. prat. F±I+, Lotus corn. ♀ ? F+I+, Pisum sat. ♀ F+I+, Rubus frutic., Geum japon., Ulmar. Filip., Spir. sorbif., S. salicif., S. ulmif., Crat. oxyac., Pyrus Malus, Philad. coron., Bryon. dioica ♀ (F+I+), B. alba ♀ (F+I+), Sedum refl., Carum Car., Aneth. grav., Viburn. opul., Weigel. ros. ? F+I+, Symphoric. racem. ♀ F+I+, Knaut. arv., Aster sparsifl., Silph. Asterisc., Heliops. laev., Rudb. specios., Doronic. austriac., Card. crisp., Centaur. Scab., Cichor. Int., Picr. hierac., Tarax. off., Crep. rubra, Campan. rapunculoides, C. glom., Vacc. uligin., Phacel. tanacetif., Borago off., Symphyt. off., Echium vulg., Myosot. vers., Verbasc. nigr., V. phoenic., Scroph. nod. ♀ F+I+, Linar. Cymb., Pentstem. campan., P. pubesc., P. ovat., P. procer., Veron. Cham., V. mont., Plectranth. glaucocalyx, Salv. off. ♀ F+I+, S. verticill. ♀ F+I+, Monarda fistul., Nepeta Muss. ♀ F+I+, N. lophantha, Lam. purp. F±I±, L. gargan., L. flexuos., Verben. hastat., Euphorb. pil., Asparag. off.

1589. H. sexsignatus *Schenck.*—Ranunc. acris, R. rep., R. bulb., Sinap. arv., Tarax. off.

1590. H. sexstrigatus *Schenck.*—Batrach. aquat., Chelidon. majus, Teesdal. nudicaul., Stell. med., Rhus Cotinus, Prunus Armen., Fragaria vesca, Potent. Anser., P. rept., P. verna, Spir. sorbif., S. salicif., S. ulmif., Bryon. dioica ♀ (F+I+),

Hypoch. radic., Vacc. uligin., Veron. mont., V. Beccab., Salv. prat. F±I+, Salix cin., S. Capr., S. aurit.

1591. H. smeathmanellus *K.* ♀.—Ranunc. acris, R. rep., R. bulb., Aquil. vulg. F+I+, Papav. Rhoeas, Teesdal. nudicaul., Raphanus Raphan., Res. odor., Sil. Otit., Malva sylv., Geran. pyren., Trif. rep. F+I+, T. med., Lotus corn. ♀ F±I±, Prunus spin., Rubus frutic., Epil. angust., Anthr. sylv., Symphoric. racem. ♀ F+I+, Achill. Millef., A. Ptarm., Tanac. Part., Card. acanth., Centaur. Jac., C. Cyan., Lamps. comm., Cichor. Int., Thrinc. hirt., Leont. aut., L. hast., Picr. hierac., Hypoch. radic., Tarax. off., Sonchus asp., Crep. vir., C. aurea, Campan. rot., C. Trach., Phlox pan., Conv. arv., Echium vulg., Verbasc. Thaps., Antirrh. maj. F±I±, Veron. mont., Origan. vulg., Thym. Serp., Lam. purp.

1592. H. subauratus *Rossi*.—Conv. arv.

1593. H. tarsatus *Schenck*.—Trif. rep. F+I+, Cirs. arv.

1594. *H. tetrazonius Klg.* (=H. quadricinctus *K.*).—Ranunc. acris, R. rep., R. bulb., Arab. aren., Cist. vill., Malva rotundif., Ruta graveol., Paliur. acul., Melilot. altiss. F+I+, Trif. prat. F±I±, Vicia pisiform. ♀ F+I+, Potent. rept., Pimpin. magn. var. ros., Heracl. Sphond., Dipsac. sylv., Solidag. Virgaur., Inula Hel., Anthem. arv., Senec. Jacob., Cirs. lanceol., Silyb. Marian., Onopord. Acanth., Centaur. Jac., C. Cyan., Cichor. Int., Tarax. off., Crep. palud., Hierac. Pilos., H. muror., Phyteum. spic., Conv. arv., Cynogloss. off., Origan. vulg., Thym. Cham., T. dalm., Ajug. genev., Euphorb. Cypar.

1595. H. tomentosus *Schenck* (cf. No. 1528).—Hypoch. radic., Marrub. vulg. F+I+.

1596. *H. flavipes F.* (=H. tumulorum *L.*, cf. Nos. 1544 and 1583).—Lotus corn. ♀ F+I+, F±I±, Rosa centif., R. pomif., Rubus Id., Potent. cinerea, P. opaca, Leont. aut., Hypoch. radic., Jas. mont., Lam. purp.

1597. *H. variipes Mor.* (=H. cephalicus *Mor.*, cf. No. 1538).—Cist. vill., Trif. nigresc., T. parvifl., Rubus caes., Sedum acre, Tordyl. apul., Spec. Spec., Conv. cantabr., Echium altiss. Lithosp. off., Scroph. canina, Thym. Cham., Teucr. Pol.

1598. *H. vestitus* (*Mor.*) *Lep.* (=H. lineolatus *Lep.*, cf. Nos. 1536 and 1552).—Spec. Spec., Teucr. Pol.

1599. H. villosulus *K.* (=*H. punctulatus K.*, cf. No. 1575), ♀ 4 mm.—Ranunc. acris, R. rep., R. bulb., Cheiranth. Cheiri, Helianth. vulg., Vit. vinif., Geran. pal., Dorycn. herbac., Rubus frutic., Potent. arg., P. hirta, Spir. sorbif., S. salicif., S. ulmif., Orlaya grand., Achill. Millef., A. Ptarm., Chrys. Leuc., Senec. Jacob., Centaur. Jac., Thrinc. hirt., Leont. aut., L. hast., L. asp., L. crisp., Picr. hierac., Hypoch. radic., Tarax. off., Sonchus olerac., Crep. bien., C. vir., C. tector., Hierac. Pilos., H. umbell., Jas. mont., Call. vulg., Conv. arv., C. cantabr., Veron. Cham., V. Beccab., Salv. prat. ↓, Thym. Serp., T. Cham., Euphorb. Cypar.

1600. *H. virescens Lep.* (=H. subauratus *Rossi*).—Sedum acre, Verben. off.

1601. H. vulpinus *Nyl.*—Foenic. vulg., Tarax. off.

1602. H. xanthopus *K.*—Aquileg. vulg., Corydal. lutea, Trif. alpin., Knaut. arv., Hypoch. radic., Tarax. off., Anchusa off., Salv. prat. ♀ F+I+, S. verticill. ♀ F+I+, Rosm. off., Lam. alb. ♀ and ♂ F+I+ ?, Ajug. rept. F+I+, Salix sp.

1603. H. Zonulus *Sm.*, 4 mm.—Ranunc. acris, R. rep., R. bulb., Chelidon. majus, Cochlear. Armorac., Res. odor., Malva sylv., Geran. pal., Impat. Noli-tang., Saroth. scop. F±I±, Trif. rep. F+I+, T. arv. ♀ F+I+, Rubus frutic., Potent. Anser., P. frutic., Ulmar. Filip., Sorbus Auc., Sedum Teleph., Pimpin. magn. var. ros., Knaut. arv., K. sylv., Succ. prat., Solidag. canad., Helianth. mult., Chrys. Leuc., Senec. Jacob., Cirs. lanceol., C. pal., Card. nut., Centaur. Jac., Thrinc. hirt., Leont. aut., Picr. hierac., Hypoch. radic., Tarax. off., T. salin., Crep. bien., C. vir., Hierac. Pilos., H. umbell., Vacc. Myrt., Conv. sep., Borago off., Myosot. hisp., M. vers., Scroph. nod. ♂ F+I+, Antirrh. maj. F±I±, Veron. Cham., V. mont., V. arv., Mentha sylv., Ajug. rept. ? F±I+, Lysim. vulg.

1604. H. sp.—Ranunc. Fic., Eroph. verna, Res. lutea, Helianth. vulg., Cist. salviif., Holost. umbell., Cerast. arv., Vit. vinif., Medic. lupul., Vicia tetrasp., Toril. Anthr., Lonic. nigra, Valer. off., Senec. nemor., Cirs. pal., Carl. acaul., Centaur. Cyan., Leont. aut., Lobel. Erin., Trachel. coer., Asclep. syr. F±I±, Antirrh. majus F±I±, Linar. vulg. F±I±, Digit. ambigua, Veron. Teucr., Ocymum, Thym. vulg., Clinop. vulg., Ball. nigr., Prun.

vulg., Plantag. lanc., Euphorb. segetal., Commelin. tuber., Sabal. Adans., Tulipa sylv., Seubert. laxa.

1605. *Heriades nigricornis Nyl.* (=Eriades nigricornis *Nyl.*, cf. Nos. 1422 and 1486).—Lythrum. Sal. ♂ F+I+, Echium vulg.

1606. *H. truncorum L.* (=E. truncorum *L.*, cf. Nos. 1487 and 1870).—Melilot. altiss. F+I+.

1607. Lithurgus chrysurus *Fonsc.*—Centaur. Biberst., C. solstit., Thym. dalm.

1608. L. fuscipennis *Lep.*—Centaur. Biberst., C. solstit.

1609. *Macrocera ruficollis Brull.* (=Eucera ruficollis *Brull.*, cf. No. 1514).—Salv. off.

1610. Macropis frivaldskyi *Mocs.*—Lysim. vulg.

1611. M. labiata *Pz.*—Rhamn. Frang., Melilot. albus F+I+, Rubus frutic, R. caes., Epil. angust., Lythr. Sal. F+I+, Knaut. arv., Cirs. arv., Picr. hierac., Lysim. vulg. F+I+.

1612. M. labiata *F.* var. fulvipes *F.*—Rubus caes., Oenanthe fistul.

1613. Megachile analis *Nyl.*—Lotus corn. ♀ and ♂ F±I±, Phyteum. betonicif., Eric. Tetr.

1614. M. analis *Nyl.* var. obscura *Alfk.*—Lotus corn. ♀ F+I+.

1615. M. apicalis *Spin.*—Lotus corn., Centaur. Calcitr., C. aren.

1616. M. argentata *F.*, 6 mm.—Geran. prat., Ononis rep., Medic. sat. ♀ and ♂ F+I+, M. falc., Trif. arv. ♀ and ♂ F+I+, T. nigresc., Lotus corn. ♀ and ♂ F+I+, Onobr. viciif., Knaut. arv., Achill. Millef., Centaur. Jac., C. Scab., C. rhen., Hierac. umbell., Jas. mont., Echium vulg., Salv. Bertol., Thym. Serp., T. Cham., Stach. ital., Ball. nigr. ♀ F+I+, Teucr. flavum.

1617. M. bicoloriventris *Mocs.*—Stach. ital.

1618. M. centuncularis *L.*, 6–7 mm.—Diclytra spectab. F±I+, Malva sylv., Dictamn. albus var. ros., Genista tinct. F+I+, Lupin. polyph., Medic. Sat. ♀ F+I+, M. carst., Trif. pann., Lotus corn. F+I+, Coron. var. ♀ F+I+, Desmod. canad., Onobr. viciif., Vicia Cracca F+I+, Lathyrus sylvest. ♀ F+I+, L. brachypterus, Rubus caes., R. Id., Epil. angust., Lythr. Sal. ♂ F+I+, Sedum acre, Heracl. Sphond., Symphoric. racem. ♂ F+I+, Lonic. tatar., Knaut. arv., Inula hir., I. Conyza, Helianth. multifl., Rudb. lacin., Doronic. austriac., Ligul. macroph., Arnica Chamiss., Calend. off., Cirs. lanceol., C. pal., Card. crisp., C. acanth., Lappa toment., Centaur. Jac., C. nigr., C. mont., C. dealb., Hypoch. radic., Tarax. off., Lactuca vimin., Sonchus arv., Crep. rigid., Hierac. vulgat., Jas. mont., Conv. sep., Borago off., Echium vulg., Atropa Bell., Antirrh. maj. (F+I+), Lavand. vera, Salv. prat. ♂ F+I+, S. Bertol., Thym. Serp., Nepeta nuda, Stach. recta ♂ F+I+, Asparag. off.

1619. M. circumcincta *K.* ♀.—Dictamn. albus var. ros., Genista tinct. F+I+, G. sagitt., Cytis sagitt., Lupin. lut. ♀ F+I+, L. angustif. ♀ F+I+, L. polyph., Ononis spin. ♀ F+I+, O. rep., Medic. carst., Trif. prat. ♀ F+I+, T. med., Lotus corn. ♀ and ♂ F+I+, Onobr. viciif., Vicia Cracca ♀ F+I+, V. sep. ♀ F+I+, V. pisiform. ♀ F+I+, V. unijuga, Lathyr. prat. ♂ F+I+, L. sylvest. ♀ F+I+, L. tuberosus ♀ F+I+, L. mont. ♂ F+I+, Rosa can., Rubus frutic., Sedum acre, Lonic. tatar., Knaut. arv., Helianth. an., Calend. off., Carl. vulg., Hierac. Pilos., Eric. Tetr., Echium vulg., Melamp. prat. ♀ F+I+, M. nemor., Thym. Serp., Prun. vulg. F+I+, Plantag. med.

1620. M. ericetorum *Lep.* (cf. No. 1621).—Geran. prat., Lupin. polyph., Lotus corn., Hedys. coron., Lathyr. latif., L. varieg., Saxifr. umbrosa, Scab. atrop., Centaur. mont., Digit. purp., Stach. recta, Prun. vulg., Asparag. off., A. acutif., A. amar.

1621. *M. fasciata Sm.* (=M. ericetorum *Lep.*, cf. No. 1620).—Ononis rep., Lotus corn. ♀ and ♂ F+I+, Astrag. narbon., A. Onobr., Coron. var. ♀ F+I+, Desmod. canad., Onobr. viciif., O. mont., Lathyr. tuberosus ♂ F+I+, L. latif., L. latif. var. ensif., L. latif. var. intermed., L. grandifl., L. brachypt., L. rotundif., Orobus hirs., Lythr. Sal. ♂ F+I+, Silyb. Marian., Centaur. rhen., Borago off., Myosot. sylv., Antirrh. maj., Lavand. vera, Salv. prat., S. argent., S. Bertol., S. Baumg., Stach. germ. ♂ F+I+, S. germ. var. villosa, S. cretica, S. lanata, Ball. nigr. F+I+.

1622. M. lagopoda *L.* (cf. No. 1634), 10 mm.—Ononis spin. ♀ and ♂ F+I+, Medic. carst., Colutea arboresc. ♀ F+I+, Coron. var. ♀ F+I+. Peuced. cerv., Dipsac. sylv., Cirs. lanceol., C. erioph., Card. crisp., C. acanth., C. nut., Onopord. Acanth., Carl. vulg., Centaur. Jac., C. aren., C. Fisch., C. ruthen., Campan. carpath., Ball. nigr. F+I+.

1623. M. lefeburei *Lep.*—Echium vulg., Stach. recta, S. ital., Marrub. candidiss., Teucr. Cham.
1624. M. ligniseca *K.*—Malva sylv., Cirs. pal., Onopord. Acanth., Centaur. Scab., Stach. pal.
1625. M. manicata *Gir.* (cf. No. 1416).—Coron. Emer., Salv. Bertol., Rosmar. off., Ajug. genev.
1626. M. maritima *K.*, 8–9 mm.—Lupin. lut. ♀ F+I+, L. angustif., Ononis spin. ♀ and ♂ F+I+, Trif. arv. ♂ F+I+, Lotus corn. ♀ and ♂ F+I+, Hedys. coron., Vicia Cracca ♀ F+I+, Pisum sat. ♂ F+I+, Lathyr. prat. ♂ F+I+, L. sylvest. ♀ F+I+, L. latif., Phaseolus vulg. ♀ ? F+I+, Rubus caes., Sedum refl., Dipsac. sylv., Knaut. arv., Cirs. lanceol., C. pal., Centaur. Cyan., C. rhen., Leont. aut., Campan. rot., Jas. mont., Anchusa off., Lycops. arv., Echium vulg., Linar. vulg. ♂ F+I+, Thym. Serp., Marrub. candidiss.
1627. M. melanopyga *Costa.*—Centaur. Jac., C. Scab., C. rhen., Melamp. nemor.
1628. M. muraria *Retz.* (cf. No. 1417).—Malva sylv., Spart. junc., Dorycn. hirs., Trif. rep. F+I+, T. nigresc., Lotus corn., Astrag. Onobr., Coron. var., Hippocrep. com., Helichrys. ang., Anchusa panic., Salv. Bertol., Thym. Cham., T. dalm., Stach. recta, S. ital., S. germ., Marrub. candidiss., Ajug. genev., Salix sp.
1629. M. nigriventris *Schenck* (=*M. ursula Gerst.*).—Trif. alp. F+I+, T. rub.
1630. M. octosignata *Nyl.*—Centaur. rhen., Asparag. off.
1631. *M. pacifica Pz.* (=M. rotundata *F.*).—Res. odor., Cirs. pal.
1632. M. pilicrus *Mor.*—Centaur. aren.
1633. M. pyrenaica *Lep.* (cf. No. 1418).—Trif. prat., Lotus corn., Hippocrep. com., Campan. persic.
1634. *M. pyrina Lep.* (=M. lagopoda *L.*, cf. No. 1622).—Medic. sat. F+I+, Lotus corn. ♀ and ♂ F+I+, Pisum sat. ♀ and ♂ F+I+.
1635. M. sericans *Fonsc.*—Marrub. vulg. F+I+, M. candidiss., Teucr. Pol.
1636. M. versicolor *Sm.*—Genista tinct. F+I+, Ononis spin. ♀ F+I+, Lotus corn. F+I+, Vicia Cracca ♀ F+I+, V. pisiform. ♀ F+I+, Lathyrus prat. F+I+, Epil. angust., Card. acanth.
1637. M. willughbiella *K.*—Malva sylv., Dictamn. alb., Genista tinct. ♀ F+I+, Medic. sat. ♂ F+I+, Trif. rep. F+I+, T. prat. F+I+, Lotus corn. ♀ and ♂ F+I+, Astrag. glycyph. ♂ F+I+, Onobr. viciif., Vicia Cracca ♀ F+I+, V. onobrych., V. unijuga, Lathyr. prat. ♀ F+I+, Glycine chin. ♂ F+I+, Lonic. tatar., Knaut. arv., Card. acanth., Hierac. umbell., Campan. rot., Echium vulg., Lithosp. off., Lavand. vera, Stach. lanata, Prun. vulg. F+I+, Teucr. Scorod. F+I+.
1638. M. sp.—Cytis. nigric., Vicia sep., Polemon. caerul., Salv. prat.
1639. Melecta armata *Pz.* (=M. punctata *K.*, cf. No. 1642).—Sisymbr. austriac., Tarax. off., Syring. vulg., Pulm. sacch., Veron. Cham., Lavand. vera, Thym. Cham. var. pannon., Nepeta Muss. ♀ F+I+, N. Glech. ♂ F+I+, Lam. alb. ♀ F+I+, L. purp. ♀ and ♂ F+I+, L. amplexic. F+I+, Ajug. rept., Hyac. orient.
1640. M. funeraria *Sm.*—Thym. Cham., T. dalm., Teucr. Cham.
1641. M. luctuosa *Scop.*, ♀ 11 mm.—Acer Pseudoplat., Colutea arboresc., Astrag. Onobr., Potent. Anser., Lythr. Sal. F+I+, Cirs. olerac., Anchus. off., Lycops. arv., Echium vulg., Lycium vulg., Veron. Cham., Salv. prat. ? F+I+, Thym. dalm., Ajug. rept. F+I+, Teucr. Cham. F+I+, Scilla marit., Hyac. orient.
1642. *M. punctata K.* (=M. armata *Pz.* cf. No. 1639).—Nepeta Glech. ♀ and ♂ F+I+, Lam. alb. F+I+.
1643. Melitta dimidiata *Mor.*—Trif. prat. F+I+, Onobr. viciif.
1644. M. haemorrhoidalis *F.* (cf. No. 1423).—Camp. rot., C. rapunculoides, C. Trach., Thym. Serp.
1645. M. haemorrhoidalis *F.* var. nigra *Friese.*—Lythr. Sal.
1646. M. leporina *Pz.* (cf. Nos. 1424 and 1426).—Medic. sat. F+I+, Trif. rep. ♀ and ♂ F+I+, T. prat. ♀ F+I+, T. arv. ♀ and ♂ F+I+, Lotus corn. ♂ F+I+, Knaut. arv., Tanac. vulg., Leont. aut., Hierac. umbell.
1647. M. melanura *Nyl.* (cf. No. 1425).—Helianth. vulg., Lythr. Sal., Euphras. Odont.
1648. Meliturga clavicornis *Ltr.*—Trif. rep. F+I+, Lotus corn. F+I+, Onobr. viciif. F+I+, Salv. sylv. F+I+.

1649. Nomada alboguttata *H.-Sch.*—Prunus Cer., Hierac. Pilos., Ajug. rept., Salix alba, S. fragil., S. rep.
1650. N. alboguttata *H.-Sch.* var. pallescens *H.-Sch.*—Sinap. arv., Salix cin., S. Capr., S. aurit.
1651. N. alternata *K.* (=*H. marshamella K.*).—Ranunc. Fic., Brass. Rapa, Stell. med., Acer Pseudoplat., Genista angl., Prunus avium, P. spin., Ribes Gross., Tarax. off., Salix alba, S. fragil., S. vimin.
1652. N. armata *H.-Sch.*—Knaut. arv.
1653. N. bifida *Ths.* ♂ 2 mm.—Ranunc. Fic., Brass. Rapa, B. Nap., Stell. Holost., Acer Pseudoplat., Potent. verna, Ribes Gross., Tussil. Farf., Tarax. off., Hierac. Pilos., Vacc. Myrt., Salix alba, S. fragil., S. vimin.
1654. N. borealis *Zett.*—Ranunc. Fic., Ribes rubr., R. aur., Tussil. Farf., Tarax. off., Vacc. Myrt., S. alba, S. fragil.
1655. N. braunsiana *Schmiedekn.*—Thym. dalm.
1656. N. brevicornis *Mocs.*—Scab. Columb., Senec. Jacob., Hypoch. radic., Jas. mont., Call. vulg.
1657. N. chrysopyga *Mor.*—Sisymbr. orient.
1658. N. corcyrea *Schmiedekn.*—Veron. Cham.
1659. N. fabriciana *L.* (cf. No. 1668).—Rubus frutic., Potent. arg., Ribes Gross., Knaut. arv., Tussil. Farf., Senec. Jacob., Leont. aut., Tarax. off., Hierac. Pilos., Jas. mont., Salix cin., S. Capr., S. aurit., S. alba. S. fragil., Gagea spath., Muscari racemos.
1660. N. fabriciana *L.* var. nigrita *Schenck* (cf. No. 1678).—Prunus Cer., Cirs. arv., Jas. mont.
1661. N. femoralis *Mor.*—Thym. dalm.
1662. N. ferruginata (*K.*) *L.*—Medic. falc., Sedum acre, Heracl. Sphond., Ebul. humil., Senec. Jacob., Hierac. Pilos., Vacc. uligin.
1663. N. flavoguttata *K.*—Stell. Holost., Potent. rept., Bellis per., Tarax. off.. Crep. vir., Hierac. Pilos., Jas. mont., Veron. Cham., Thym. Cham., Salix sp.
1664. N. flavoguttata *K.* var. höppneri *Alfken.*—Tussil. Farf., Bellis per.
1665. N. fucata *Pz.* (cf. No. 1696).—Ranunc. Fic., Medic. Falc., Senec. Jacob., Tarax. off., S. alba, S. fragil.
1666. N. furva *Pz.* (cf. No. 1676).—Achill. Millef., Senec. Jacob., Campan. rot., Lam. mac., Salix cin., S. Capr., S. aurit.
1667. N. fuscicornis *Nyl.*—Leont. aut., Hypoch. radic., Crepis vir., Jas. mont.
1668. *N. germanica Pz.* (=N. fabriciana *L.*, cf. No. 1659).—Veron. Cham., Thym. Serp.
1669. N. guttulata *Schenck.*—Geran. sanguin., Anthr. sylv., Veron. Cham., Salix sp.
1670. N. jacobaeae *Pz.*—Lotus corn. ♀ F±I+, Potent. sylv., Epil. angust., Knaut. arv., Succ. prat., Scab. suav., Senec. Jacob., S. erucif., Cirs. arv., Centaur. rhen., Jas. mont., Call. vulg., Origan. vulg., Galeops. Ladan. ♀ ? F+I+.
1671. N. imperialis *Schmiedekn.*—Salv. Bertol., Thym. Cham.
1672. N. lateralis *Pz.* (=N. xanthosticta *K.*, cf. No. 1698).—Cardam. prat., Malva sylv., Hyper. perfor., Rubus frutic., Dauc. Car., Echium vulg., Euphras. off., Salix cin., S. Capr., S. aurit.
1673. N. lathburiana *K.*—Tarax. off., Salix cin., S. Capr., S. aurit., S. alba, S. fragil.
1674. N. lineola *Pz.* (cf. No. 1690), 6 mm.—Ranunc. Fic., Cardam. prat., Sisymbr. austriac., Brass. Rapa, B. Nap., Hyper. perfor., Lathyrus latif., Prunus spin., Rubus frutic., Crat. Oxyac., Ribes Gross., Libanot. mont., Knaut. arv., Bellis per., Senec. Jacob., Cirs. arv., Tarax. off., Jas. mont., Vacc. Myrt., Salix cin., S. Capr., S. aurit., S. alba, S. fragil.
1675. N. lineola *Pz.* var. subcornuta *K.*—Rosmar. off.
1676. *N. minuta F.* (=N. furva *Pz.*, cf. No. 1666).—Salix cin., S. Capr., S. aurit.
1677. N. mutabilis *Mor.*—Rubus frutic.
1678. *N. nigrita Schenck* (=N. fabriciana *L.* var. nigrita *Schenck.*, cf. No. 1660).—Jas. mont.
1679. N. nobilis *H.-Sch.*—Res. lutea, Dorycn. herbac., Anchusa off., Origan. vulg.
1680. N. obscura *Zett.*—Salix spec.
1681. N. obtusifrons *Nyl.*—Potent. sylv., Heracl. Sphond., Jas. mont., Call. vulg.
1682. N. ochrostoma *K.*—Dorycn. herbac., Lotus corn. F±I+, Rubus frutic., R. Id., Liban. mont., Hierac. Pilos., Veron. Cham., Ajug. rept.
1683. N. ochrostoma *K.* var. hillana *K.*—Ribes Gross.
1684. N. rhenana *Mor.* (cf. No. 1689).—Prunus Cer., Tanac. vulg., Senec. Jacob.

1685. N. roberjeotiana *Pz.*—Trif. mont. F+I+, Rubus frutic., Epil. angust., Eryng. camp., Succ. prat., Scab. suav., Achill. Millef., Senec. Jacob., S. erucif., Cirs. arv., Jas. mont., Call. vulg.

1686. N. ruficornis *L.*—Ranunc. Fic., Brass. Rapa, B. Nap., Alyss. mont., Stellar. Holost., Acer Pseudoplat., Trif. mont. F+I+, Lotus corn. F+I+, Rubus rutic., Fragaria vesca, Potent. Anser., P. verna, Spir. sorbif., S. salicif. S. ulmif., Crat. Oxyac., Sorbus Auc., Ribes Gross., Inula hir., Achill. Millef., A. Ptarm., Tanac. vulg., Senec. Jacob., S. erucif., Tarax. off., Hierac. Pilos., Jas. mont., Vacc. uligin., Thym. dalm., Salix cin., S. Capr., S. aurit., S. alba, S. fragil.

1687. N. ruficornis *L.* var. flava *Pz.*—Ribes Gross., Vacc. Myrt.

1688. N. ruficornis *L.* var. signata *Jur.*—Fragaria vesca, Crat. Oxyac., Sorbus Auc., Valerian. olit., Tarax. off., Salix cin., S. Capr., S. aurit.

1689. *N. rufipes Schenck* (=N. rhenana *Mor.*, cf. No. 1684).—Jas. mont.

1690. *N. sexcincta K.* (=N. lineola *Pz.*, cf. No. 1674).—Vacc. uligin.

1691. N. sexfasciata *Pz.* ♂ 8 mm.—Saroth. scop., Fragaria vesca, Senec. Jacob., S. erucif., Anchusa off., Echium vulg., Thym. dalm., Rosmar. off., Orchis latif. F+I+.

1692. N. similis *Mor.*—Rubus frutic., Jas. mont.

1693. N. solidaginis *Pz.*—Medic. falc., Potent. sylv., Succ. prat., Scab. suav., Solidag. Virgaur., Achill. Millef., Senec. Jacob., S. erucif., Cirs. arv., Leont. aut., Jas. mont., Call. vulg., Eric. Tetr.

1694. N. succincta *Pz.*, 6½–7 mm.—Cardam. prat., Brass. oler., B. Rapa, Acer Pseudoplat., Genista angl., Trif. minus, Prunus spin., Potent. rept., Crat. Oxyac., Ribes Gross., Heracl. Sphond., Tarax. off., Vacc. Myrt., V. uligin., Ligustr. vulg., Rosmar. off., Salix cin., S. Capr., S. aurit., S. alba, S. fragil., S. rep.

1695. *N. trispinosa Schmiedekn.* (=N. melanostoma *Thoms.*).—Tarax. off., Salix sp.

1696. *N. varia Pz.* (=N. fucata *Pz.*, cf. No. 1665).—Senec. Jacob., Tarax. off., Sonchus arv., Jas. mont., Nepeta Glech. ♀ flowers F+I+.

1697. N. verna *Mocs.*—Muscari racemos.

1698. N. xanthosticta *K.* (cf. No. 1672).—Ranunc. Fic., Brass. Rapa, Prunus spin., Potent. rept., Ribes Gross., Tarax. off., Echium vulg., S. alba, S. fragil.

1699. N. zonata *Pz.*—Achill. Millef., A. Ptarm., Senec. Jacob., S. erucif., Tarax. off., Salix sp.

1700. N. sp.—Coryd. cava F±I+, Valerian. olit.

1701. Nomia diversipes *Ltr.*—Res. lutea, Linum grandifl., Paliur. acul., Dorycn. herbac., Melilot. altiss. F+I+, Thym. Serp.

1702. N. femoralis *Pall.*—Onobr. aren., Eryng. camp., Anchusa off., Thym. Serp.

1703. *Nomioides pulchella Schenck* (=Halictus pulchellus *Schenck*, cf. No. 1573).—Jas. mont., Stach. recta.

1704. Osmia acuticornis *Duf. et Perr.* (=*O. dentiventris Mor.*, and O. hispanica *Schmiedekn.*).—Viola odor., Hippocrep. com., Rubus frutic.

1705. O. adunca *Panz.*, 10 mm.—Geran. Robert., Lotus corn. ♀ and ♂ F+I+, Vicia Cracca ♀ F+I+, Lythr. Sal. ♂ F+I+, Silyb. Marian., Cichor. Int., Campan. glom., Cynogloss. off., Anchusa off., Echium vulg., Lavand. vera, Salv. prat. ♂ F+I+, S. verticill. ♂ F+I+, Nepeta nuda, N. Muss. ♀ F+I+, Lam. purp. ♂ ↑, Ball. nigr. ♀ and ♂ F+I+, Gladiol. comm.

1706. *O. aenea L.* (=O. caerulescens *L.*, cf. No. 1715), 9–10 mm.—Ranunc. acris, R. rep., R. bulb., Malva sylv., Geran. rubell., Lupinus polyph., Ononis spin. ♀ F+I+, Medic. sat. ♀ F+I+, Trif. prat. ♀ F+I+, Lotus corn. ♀ and ♂ F+I+, Coron. var. ♀ F+I+, Onobr. viciif., O. aur., Vicia onobrychoides, Glycine chin. ♀ F+I+, Knaut. arv., Card. acanth., Centaur. Scab., Tarax. off., Crep. palud., Hierac. Pilos., Symphyt. off., Echium vulg., Lithosp. purp.-caer., Linar. vulg. ♀ F+I+, Veron. Cham., Lavand. vera, Salv. prat. ♀ F+I+, S. off. ♀ and ♂ F+I+, S. verticill. ♀ F+I+, Nepet. Cat. ♀ F+I+, N. Muss. ♀ F+I+, N. Glech. ♀ F+I+, Lam. mac., L. gargan., L. flexuos., Phlom. armen., Ball. nigr. ♀ F+I+, Scutell. albida, Ajug. rept. F+I+, Scilla marit.

1707. O. angustula *Zett.*—Lotus corn.

1708. O. anthrenoides *Spin.*—Malva sylv., Dorycn. herbac., Lotus corn. F+I+, Hippocrep. corn., Lam. purp. F+I+, Ajug. genev. F+I+, Teucr. mont. F+I+.

1709. O. aurulenta *Pz.*, 8–9 mm.—Coryd. lutea, Malva sylv., Onon. spin. ♀ F+I+,

Medic. falc., Trif. prat. F+I+, Lotus corn., Oxytrop. pil. ♀ F+I+, Astrag. Onobr., Hippocrep. com., Onobr. viciif., Vicia sep. F+I+, Prunus avium, P. spin., Rubus caes., Potent. verna, Ribes aur., Card. acanth., Onopord. Acanth., Tarax. off., Echium vulg., Salv. Bertol., Origan. vulg., Thym. Cham., Nepeta Glech. ♀ and ♂ F+I+, Lam. purp. F+I+, Ball. nigr. ♀ F+I+, Ajug. rept. F+I+, Teucr. Scorod., Scilla marit.

1710. O. bicolor *Schr.* (=*O. fusca Chr.*, cf. No. 1730), 8 mm.—Pulsat. prat. F+I+, Anem. nem., Ranunc. lanugin., Brass. Rapa, B. Nap., Viola odor., V. can. ♀ F+I+, Polyg. Chamaeb., Lotus corn. ♀ F+I+, Geum riv., Fragaria vesca, Potent. verna, P. cinerea, P. opaca, Erica carn., Echium vulg., Ajug. rept., Salix sp., Orchis latif. F+I+, Croc. vern., Scilla marit.
1711. *O. bicornis L.* (=O. rufa *L.*, *cf.* No. 1754).—Persica vulg., Prunus Cer., Crat. Oxyac., Ribes sanguin., R. Gross., Lam. alb. ♀ F+I+, L. purp. F+I+, Ajug. rept. F+I+, Salix Capr.
1712. O. bidentata *Mor.*—Centaur. Biberst., C. solstit.
1713. O. bisulca *Gerst.*—Sisymbr. orient.
1714. *O. caementaria Gerst.* (=O. spinolae *Schenck*, cf. No. 1758).—Anchus. off., Echium vulg., Salv. off. ♂ F+I+, S. verticill. ♀ F+I+, Pinguic. vulg. ♂ F+I+.
1715. O. caerulescens *L.* (=*O. aenea L.*, cf. No. 1706), 5½ mm.—Ranunc. acris, R. rep., R. bulb., Sisymbr. austriac., Malva sylv., Geran. Robert., Trif. prat. ♂ F±I±, Fragaria vesca, Tarax. off., Crep. bien., Anchusa off., Nepeta Glech. ♀ and ♂ F+I+, Lam. alb. F+I+, L. purp. F+I+, Stach. sylv. F+I+, Ajug. rept., A. genev.
1716. O. campanularis *Mor.*—Hippocrep. com.
1717. O. cephalotes *Mor.*—Paliur. acul.
1718. O. cerinthidis *Mor.*—Cerinthe maj.
1719. *A. claviventris Thoms.* (=O. leucomelaena *K.*).—Melilot. altiss. F+I+, M. off. F+I+, Trif. prat. ♂ F±I±, Lotus corn. ♀ F+I+, Inula Hel., Centaur. Cyan., Hierac. Pilos., Campan. rot., Echium vulg.
1720. O. confusa *Mor.*—Cirs. spinosiss., Card. acanth.
1721. O. cornuta *Ltr.*, 8–9 mm.—Coryd. lutea, Viola odor. ♀ F+I+, Polyg. Chamaeb., Astragal. Onobr., Amygd. comm., Persica vulg., Prunus dom., P. avium, P. Cer., Nepeta Glech. F+I+, Salix alba, Scilla sibir., Hyac. orient.
1722. *O. corticalis Gerst.* (=O. nigriventris *Zett.*, cf. No. 1746).—Vacc. Myrt., Nepeta Glech. F+I+.
1723. O. crenulata *Mor.*—Dorycn. herbac.
1724. O. dalmatica *Mor.*—Echium vulg.
1725. O. difformis *Pér.* (cf. No. 1748).—Lotus corn.
1726. O. dives *Mocs.*—Centaur. Biberst., C. solstit.
1727. O. emarginata *Lep.* (cf. No. 1745).—Acer Pseudoplat., Anchusa off., Ajug. rep., A. genev.
1728. O. fuciformis *Ltr.*—Lotus corn. ♀ F+I+, Lam. alb.
1729. O. fulviventris *Pz.*—Sisymbr. austriac., S. orient., Geran. prat., Cytis. sagitt., Hippocrep. com., Onobr. viciif., Sedum acre, Valer. asarif., Knaut. arv., Doronic. Pardal., D. austriac., Senec. Doronic., Cirs. arv., C. heteroph., Silyb. Marian., Card. crisp., C. acanth., C. Person., C. nut., C. pycnoceph., Onopord. Acanth., Jurin. moll., Rhapont. pulch., Centaur. mont., C. dealb., C. Fisch., C. ochrol., C. Salonit., Tragop. floccos., Scorzon. hisp. var. glastif., S. parvifl., Achyroph. macul., Mulged. alpin., Crep. bien., C. mont., C. succisifol., Hierac. vulgat., H. muror., H. echioid., H. Retzii, Borago off., Lavand. vera, Marrub. candidiss., Ball. nigr. ♀ F+I+, Ajug. rept. F+I+, Camassia Fraseri.
1730. *O. fusca Chr.* (=O. bicolor *Schr.*, cf. No. 1710), 8 mm.—Geran. pyren., Saroth. scop. F±I±, Prunus avium, Rubus frutic., Potent. verna, Tarax. off., Vinca min., Pulm. off., Echium vulg., Nepeta Glech. F+I+, Ajug. rept. F+I+, Daphne Mez., Orchis latif. F+I+, Scilla marit.
1731. O. gallarum *Spin.*—Trif. nigresc., Hippocrep. com.
1732. O. giraudi *Schmiedekn.*—Hippocrep. com.
1733. O. grandis *Mor.*—Melilot. albus F+I+.
1734. O. insularis *Schmiedekn.*—Echium vulg., Hippocrep. com.
The species found in the latter plant is—
1735. O. jheringi *Ducke* (*teste* Ducke).

1736. O. latreillei *Spin.*—Lotus corn.
1737. O. lepeletieri *Pér.*—Lotus corn., Hippocrep. com., Echium vulg.
1738. *O. leucomelaena* (*K.*) *Schmiedekn.* (=O. parvula *Duf. et Perr.*), 2½ mm.—Linum austr., Lotus corn., Hippocrep. com., Rosa pomif., Rubus frutic., Aruncus sylv., Heracl. Sphond., Achill. Millef., A. Ptarm., Leont. hast., Picr. hierac., Campan. pat., Echium vulg., Linar. vulg. F+I+.
1739. O. ligurica *Mor.*—Lotus corn.
1740. O. longiceps *Mor.*—Hippocrep. com.
1741. O. macroglossa *Gerst.*—Onosma stell.
1742. O. maritima *Friese.*—Brass. oler., Viola can., Lotus corn. ♀ and ♂ F+I+, Phaseolus vulg. ♀ F+I+, Potent. Anser., Salix rep.
1743. *O. montivaga Mor.* (=O. mitis *Nyl.*).—Anthem. arv., Teucr. mont.
1744. O. morawitzi *Gerst.* (=*O. loti Mor.*).—Lotus corn., Astrag. alp.
1745. *O. mustelina Gerst.* (=O. emarginata *Lep.*, cf. No. 1727).—Anchus. off.
1746. O. nigriventris *Zett.* (cf. No. 1722).—Lotus corn. F+I+, Vacc. Myrt., V. Vit.-id., Rhodod. hirs., Nepeta Glech. F+I+.
1747. O. notata *F.*—Anchusa off., Echium vulg.
1748. *O. pallicornis Friese* (=O. difformis *Pér.* (*teste* Ducke), cf. No. 1725).—Hippocrep. com., Salv. Bertol.
1749. O. panzeri *Mor.*—Sisymbr. orient.
1750. O. papaveris *Ltr.*—Papaver Rhoeas, Centaur. Cyan., C. Fisch., Campan. glom., Conv. arv., Thym. Cham.
1751. O. pilicornis *Sm.*—Viola odor., Lotus corn. ♀ F+I+, Pulm. off.
1752. *O. platycera Gerst.* (=O. villosa *Schenck*, cf. No. 1766).—Genista tinct. F+I+.
1753. O. rubicola *Friese.*—Hippocrep. com., Onobr. viciif.
1754. O. rufa *L.* (=*O. bicornis Lep.*, cf. No. 1711), 7–9 mm.—Clemat. recta, Hepat. triloba, Pulsat. vulg. F+I+, Ranunc. acris, R. rep., R. bulb., R. Fic., Caltha pal., Epimed. pinnat., Papav. nudicaule, P. Burseri, Diclytra spectab. F±I+, Arab. alb., A. deltoid., Cardam. prat., Brass. oler., B. Rapa, B. Nap., Iber. amara, Viola odor. ♀ and ♂ F+I+, V. can. ♂ F+I+, V. tric. arv. ↑, Coron. Fl.-cuc., Stell. med., Geran. prat., G. Robert., Medic. sat. ♀ F+I+, Lotus corn. ♀ and ♂ F+I+, Astrag. glycyph. ♀ F+I+, Hedys. obsc., Onobr. viciif., Vicia sep. ♀ F+I+ and F±I+, V. Faba ♀ F+I+, V. unijuga, Lathyr. niger ♀ F+I+, L. varieg., L. vernus var. flaccidus, Glycine chin. ♀ F+I+, Persica vulg., Prunus Armen., P. dom., P. avium., P. Cer., P. spin., Rosa can., Spir. sorbif., S. salicif., S. ulmif., Crat. Oxyac., Pyrus Malus, Philad. coron., Ribes aureum, R. sanguin., R. Gross., Bergenia Subcil., Weigel. ros. ♀ F+I+, Valer. Phu, Bellis per., Centaur. Scab., Tarax. off., Mulged. alpin., Crep. palud., Vacc. Myrt., V. uligin., Syring. vulg., S. pers., Vinca min., Phacel. tanacetif., Polemon caerul., Omphalod. vern., Borago off., Anchusa off., A. ochrol., Pulm. off., P. angustif., P. angustif. × off., P. sacch., Cerinthe min., Echium vulg., Caryolopha semperv., Myosot. P. sylv., M. alpestr. Antirrh. maj., Pentstem. pubesc., P. ovat., P. procer., Veron. opaca, Lavand. vera, Salv. prat. ♀ F+I+, S. off. ♀ F+I+, Rosmar. off., Nepeta Muss. ♀ F+I+, N. melissif., N. Glech. ♀ and ♂ F+I+, Lam. mac. var. hirs. ♀ F+I+, L. purp. ♂ F+I+, L. flexuos., Stach. sylv. ♀ F+I+, Ball. nigr. ♀ F+I+, Ajug. rept. F+I+, Prim. elat. ♂, Daphne Mez., Salix cin., S. Capr., S. aurit., S. alba, S. fragil., S. rep., Orchis Morio F+I+, Gladiol. comm., Iris Pseudac. F±I+, Narc. Pseud.-Narc. F+I+, Scilla Sibir., Hyac. orient., Muscari neglect., M. racemos., Asparag. off.
1755. O. rufohirta *Ltr.*—Malva sylv., Hippocrep. com., Onobr. viciif., Tarax. off., Sonchus asp., Salvia Bertol., Thym. dalm., Ajug. rept.
1756. O. scutellaris *Mor.*—Thym. Cham.
1757. *O. solskyi Mor.* (=O. leaina *K.*), ♂ 6½ mm.—Sisymbr. orient., Geran. Robert., Hippocrep. com., Vicia angustif. ♀ F+I+, Cirs. arv., C. olerac., Card. nut., Onopord. Acanth., Centaur. rhen., Leont. aut., Hypoch. radic., Tarax. off., Crep. bien., C. vir., Hierac. Pilos., Echium vulg., Nepeta Glech. F+I+, Lam. purp.
1758. O. spinolae *Schenck* (=*O. caementaria Gerst.*, cf. No. 1714).—Trif. arv. ♂ F+I+, Astrag. Onobr., Card. pycnoceph., Anchusa off., Echium vulg.
1759. O. spinulosa *K.*, 5 mm.—Ononis rep., Onobr. viciif., Knaut. arv., Inula hir., Achill. Millef., A. Ptarm., Anthem. tinct., Senec. Jacob., Centaur. Jac., C. Scab., C. Biberst., C. solstit., Cichor. Int., Picr. hierac., Sonchus arv., Crepis bien., C. tector.

1760. O. tergestensis *Ducke.*—Hippocrep. com., Onobr. viciif.
1761. O. tiflensis *Mor.*—Lotus corn., Hippocrep. com., Onobr. viciif.
1762. O. tridentata *Duf. et Perr.*—Trif. rep. F+I+, T. nigresc. F+I+, Lotus corn. F+I+, Hippocrep. com. F+I+, Echium vulg.
1763. O. uncinata *Gerst.*—Viola odor., Genista angl. F+I+, Hippocrep. com., Rubus frutic., Vacc. Myrt., Pulm. off., Nepeta Glech. F+I+, Ajug. rept. F±I+.
1764. O. versicolor *Latr.*—Geran. dissect., G. molle, Trif. nigresc., Lotus corn., Onobr. viciif., Potent. cinerea, P. opaca, Sedum acre, Thym. dalm., Ajug. genev.
1765. O. vidua *Gerst.*—Thym. Cham.
1766. O. villosa *Schenck* (cf. No. 1752).—Card. deflor., Picr. hierac.
1767. O. vulpecula *Gerst.*—Lotus corn., Vacc. Myrt.
1768. *O. xanthomelaena K.* (=O. fuciformis *Ltr.*, cf. No. 1728).—Hippocrep. com., Nepeta Glech. F+I+, Lam. alb.
1769. O. sp.—Melilot. altiss. F+I+, Vicia sep. F±I+, Cynogloss. off., Solan. Dulc., Thym. Serp.
1770. *Panurgus ater Latr.* (=P. banksianus *K.*, cf. No. 1771).—Hypoch. radic., Armer. elong.
1771. P. banksianus *K.* (cf. No. 1770), 3 mm.—Ranunc. acris, R. rep., R. bulb., Cichor. Int., Leont. aut., Picr. hierac., Hypoch. radic., Sonchus arv., Crep. bien., C. vir., Hierac. Pilos., H. muror., H. umb., Conv. arv.
1772. P. calcaratus *Scop.* (=P. lobatus *Pz.*, cf. No. 1773), 3 mm.—Ranunc. acris, R. rep., R. bulb., Erysim. cheiranthoid., Oenoth. bien. ♀ and ♂ F+I+, Inul. brit., Senec. visc., Thrinc. hirt., Leont. aut., L. hast., Picr. hierac., Hypoch. radic., Sonchus arv., Crep. bien., C. vir., Hierac. Pilos., H. vulgat., H. muror., H. umbell., H. brevifol.
1773. *P. lobatus Pz.* (=P. calcaratus *Scop.*, cf. No. 1772).—Armer. elong.
1774. P. sp.—Picr. hierac., Scorzon. humil., Hypoch. radic., Lactuca mural., Crep. vir., Hierac. Pilos., H. umbell.
1775. Pasites maculatus *Jur.*—Thym. Serp., Ajug. chamaep.
1776. P. minutus *Mocs.*—Centaur. Biberst.
1777. Podalirius acervorum *L.* (=*Anthophora acervorum L.*, and *A. pilipes F.*, cf. Nos. 1331 and 1339), ♀ 14, ♂ 15 mm.—Ranunc. Ficar., Corydal. lut., Cheiranth. Cheiri, Brass. Rapa, B. Nap., Sinap. arv., Raphan. sat., Viola odor., V. can., V. tric. vulg., Stell. med., Cytis hirs., Rubus spectab., Pyrus Malus, Tarax. off., Vinca min., V. maj., Anchusa off., Pulm. off., Rosmar. off., Nepeta Glech. ♀ and ♂, Lam. alb. F+I+, L. mac. F+I+, L. purp. F+I+, Ajug. rept. F+I+, A. genev., Prim. elat. F+I+, Salix Capr., S. alba, S. fragil., Croc. vern., C. varieg., Leucoj. aest., Scilla Sibir., Hyac. orient.
1778. P. aestivalis *Pz.* (=P. retusus *L.*, cf. Nos. 1332, 1335, 1341, and 1795).—Anchusa off., Lycium vulg., Ball. nigr. F+I+.
1779. P. albigenus *Lep.*—Anchusa off.
1780. P. bimaculatus *Pz.* (cf. Nos. 1844 and 1845).—Trif. arv. ♀ and ♂ F+I+, Lotus corn., Centaur. Biberst., C. valesiaca, C. amar., Jas. mont., Eric. Tetr., Echium vulg., Thym. Serp., Galeops. Ladan. F+I+.
1781. P. borealis *Mor.*—Trif. prat. ♀ and ♂ F+I+, T. med., Vicia Cracca ♀ F+I+, Salv. sylv. ♀ and ♂ F+I+, Galeops. Tetr. ♂ F+I+, Stach. sylv. ♀ and ♂ F+I+, S. pal. ♀ and ♂ F+I+, Prun. vulg. ♀ and ♂ F+I+, Teucr. Scorod. ♀ and ♂ F+I+.
1782. P. crassipes *Lep.*—Echium vulg.
1783. P. crinipes *Sm.*—Cheiranth. Cheiri, Vinca maj., Borago off., Anchusa off., Salv. clandest., S. Bertol., Rosmar. off., Lam. mac., Ajug. genev.
1784. P. dufourii *Lep.*—Salv. prat. F+I+, S. Bertol.
1785. P. femoratus *Oliv.* (cf. No. 1333).—Echium vulg.
1786. P. fulvitarsus *Brullé* (cf. No. 1338).—Trif. prat. ♀ F+I+, Astrag. Onobr. F+I+.
1787. P. furcatus *Pz.* (cf. No. 1334), ♂ 12 mm.—Malva sylv., Epil. angust., Jas. mont., Stach. sylv. ♀ and ♂ F+I+, S. pal. ♀ and ♂ F+I+, Ball. nigr. ♀ and ♂ F+I+, Prun. vulg. ♀ and ♂ F+I+, Teucr. Scorod. ♀ and ♂ F+I+.
1788. P. magnilabris *Fedtsch.*—Anchusa off.
1789. P. nigrocinctus *Lep.*—Cheiranth. Cheiri, Raphan. sat.
1790. P. parietinus *F.* (cf. No. 1337).—Trif. prat. ♀ and ♂ F+I+, Astrag. Onobr.,

Symphoric. racem. ♀ F+I+, Scab. Columb., Symph. asperr., Nepeta Glech., Ajug. rept.

1791. P. pubescens *F.* (=*P. flabellifera F.*).—Anchusa off., Ball. nigr. ♀ and ♂ F+I+.
1792. P. quadrifasciatus *Vill.* (cf. No. 1336).—Anchusa off., Echium vulg., Ball. nigr. ♀ and ♂ F+I+.
1793. *P. quadrifasciatus Vill. var. garrulus Rossi.*—Teucr. flavum.
1794. P. raddei *Mor.*—Echium vulg., Salv. Sclar.
1795. P. retusus *L.* (cf. Nos. 1332, 1335, 1341, and 1778), ♀ 15–18, ♂ 15–20 mm.—Brass. oler., B. Rapa, B. Nap., Trif. prat. ♀ and ♂ F+I+, Astrag. Onobr., Vicia villosa F+I+, V. sep., Veron. Cham., Pedic. sylv., Nepeta Glech. ♀ and ♂ F+I+, Lam. purp. F+I+, Galeops. Tetr. ♀ and ♂ F+I+, G. ochr. ♂ F+I+, Stach. sylv. F+I+, Ball. nigr. F+I+, Prun. vulg. F+I+, Ajug. rept. F+I+, Teucr. Scorod. F+I+, T. Cham. F+I+, Salix sp.
1796. P. retusus *L.* var. meridionalis *Pér.*—Cheiranth. Cheiri, Raphan. sat., Dorycnium hirs., Vicia villosa var. varia, Salv. off. F+I+, S. Bertol., Thym. Cham., Ajug. genev., Croc. varieg.
1797. P. retusus *L.* var. obscurus *Friese.*—Aesc. Hippocast. (F+I+).
1798. P. salviae *Mor.*—Anchusa off.
1799. P. siewersi *Mor.*—Teucr. orient.
1800. P. tarsatus *Spin.*—Cytis. hirs., Colutea arboresc. F+I+, Coron. Emerus F+I+, Vicia villosa F±I±, V. varia F+I+, Echium vulg., Salv. Sclar., Thym. dalm., Nepeta Glech. F+I+, Ajug. genev.
1801. P. vulpinus *Pz.* (=P. quadrimaculatus *Pz.*, cf. No. 1340).—Oron. spin. ♀ and ♂ F+I+, Lotus corn. ♀ F+I+, Jas. mont., Anchusa off., Echium vulg., Lycium vulg., Origan. vulg., Thym. Serp., Lam. alb. F+I+, L. purp. ♀ and ♂ F+I+, Stach. sylv. ♀ and ♂ F+I+, S. pal. ♀ and ♂ F+I+, Ball. nigr. ♀ and ♂ F+I+, Teucr. Scorod. ♀ and ♂ F+I+, Allium fallax.
1802. Prosopis alpina *Mor.*—Sedum album.
1803. P. angustata *Schenck.*—Allium rot.
1804. *P. annularis Sm.* (=P. panzeri *Foerst.*).—Res. odor., Helianth. vulg., Pimpin. Saxifr., Anthr. sylv.
1805. *P. annulata L.* (=P. communis *Nyl.*, cf. No. 1811).—Chaeroph. aur., Crep. rubra, Lam. purp.
1806. *P. armillata Nyl.* (=P. hyalinata *Sm.*, cf. No. 1816).—Gypsoph. panic., Hyper. perfor., Ulmar. pentap., Aruncus sylv., Philad. coron., Sedum acre, S. album, Astrant. maj., Peuced. ruthen., Aneth. grav., Heracl. Sphond., Anthr. Ceref., Chaeroph. tem., C. bulb., Solidag. glab., Chrys. Leuc., Doronic. austriac., Senec. nemor., Leont. aut., Lactuca vimin., Sonchus asp., Hierac. Pilos., H. boreale, Anchusa ochrol., Melamp. arv., Salv. verticill. ♂ F+I+, Polygon. Pers.
1807. P. bipunctata *F.* (=P. signata *Pz.*, cf. No. 1826).—Lepid. sat., Caps. Bursa-past., Res. luteola, R. lutea, R. odor., Rubus frutic., Aruncus sylv., Achill. Millef., Tanac. vulg., Anchusa panic., Euphorb. Esula.
1808. P. borealis *Nyl.*—Potent. verna, Aruncus sylv., Carum Car.
1809. P. brevicornis *Nyl.*—Ranunc. acris, R. rep., R. bulb., Gypsoph. panic., Potent. Anser., Sedum acre, Carum Car., Angel. sylv., Gal. boreal., Achill. Millef., Matric. inod., Allium Cepa.
1810. P. clypearis *Schenck.*—Ranunc. acris, R. rep., R. bulb., Nasturt. lippic., Res. lutea, Cist. monspel., Ruta graveol., Paliur. acul., Dorycn. herbac., Potent. hirta, Ulmar. pentap., Arunc. sylv., Sedum acre, Aegop. Podagr., Peuced. pal., Orlaya grand., Anthr. sylv.
1811. P. communis *Nyl.* (cf. No. 1805), 1–1¼ mm.—Hesper. off., Brass. Rapa, Lepid. sat., Bunias orient., Res. luteola, R. odor., Gypsoph. panic., G. fastig., Aren. graminif., Malach. aquat., Malva sylv., Geran. pal., G. sylv. var. robust., G. iber. var. platypet., Rhus typhina, Rosa can., Rubus frutic., R. Id., Fragaria vesca, Potent. arg., P. verna, P. Mayeri var. Fenzlii, Ulmar. pentap., Arunc. sylv., Spir. opulif., Petrosel. sat., Aegop. Podagr., Carum Car., Pimpin. Saxifr., Aethusa cynap., Aneth. grav., Heracl. Sphond., Siler trilob., Anthr. Ceref., Chaeroph. tem., Asper. taur., Cephal. ural. var. cretac., Aster lanceol., Galatel. hyssopif., Diplopap. amygd., Solidag. glab., S. laterifl., S. livida, S. Kidel., Achill. Millef., Tanac. macroph., Chrys. Leuc., Doronic. austriac., Echinops sphaeroc., Cirs. arv., Centaur. dealb., Leont. aut., Hypoch. radic., Hierac. Pilos., H. muror., Campan. rapunculoides, C. persic., C. carpath., C. lactifl., Jas. mont., Conv. arv.,

Verbasc. nigr., Veron. spic., Salv. prat. F±I+, S. off., Nepeta nuda, Physostegia virgin., Armer. elong., Allium rot., A. Cepa.

1812. P. confusa *Nyl.*—Nigella damasc., Sinap. arv., Res. odor., Rubus frutic., R. Id., Ulmar. pentap., Epil. angust., Aegop. Podagr., Diplopap. amygd., Achill. Millef., A. Ptarm., Tanac. corymb., Cirs. arv., Hypoch. radic., Campan. persic., Jas. mont., Echium vulg., Veron. mont., Allium Cepa.
1813. P. cornuta *Sm.*—Achill. Millef.
1814. P. dilatata *K.*—Res. odor., Malva sylv., Rubus frutic., Succ. prat., Achill. Millef., Jas. mont., Asparag. off.
1815. P. genalis *Thoms.* (=*P. confusa Foerst.*).—Lepid. graminifol., Cist. monspel., Rubus caes., Jas. mont.
1816. P. hyalinata *Sm.* (=*P. armillata Nyl.*, cf. No. 1806).—Ranunc. acris, R. rep., R. bulb., Sinap. arv., Lepid. sat., Res. luteola, R. odor., Malach. aquat., Malva sylv., Geran. prat., Rubus frutic., Potent. rept., Sedum acre, Aegop. Podagr., Weigel. ros., Cirs. arv., Campan. rapunculoides, C. Trachel., C. persic., Jas. mont., Conv. arv., Echium vulg., Veron. mont., Globul. vulg.
1817. P. hyalinata *Sm.* var. corvina *Foerst.*—Orlaya grand., Anthem. arv.
1818. P. hyalinata *Sm.* var. subquadrata *Foerst.*—Paliur acul., Conv. arv.
1819. P. masoni *Saund.*—Achill. Millef.
1820. P. nigrita *F.* (cf. No. 1824).—Res. odor., Rubus frutic., Aruncus sylv., Achill. Millef., Tanac. vulg., Cichor. Int.
1821. *P. obscurata Schenck* (=P. punctulatissima *Sm.*, cf. No. 1823).—Aethusa Cynap., Allium rot.
1822. P. pictipes *Nyl.*—Caps. Bursa-past., Res. lutea, R. odor., Malva sylv., Paliur. acul., Rubus frutic., Aegop. Podagr., Heracl. Sphond., Achill. Millef., A. Ptarm., Jas. mont., Call. vulg., Allium Cepa.
1823. *P. propinqua Nyl.* (=P. nigrita *F.*, cf. No. 1821).—Anthem. tinct., Crep. vir.
1824. P. punctulatissima *Sm.* (cf. No. 1821).—Heracl. Sphond., Card. acanth., Allium Cepa.
1825. P. rinki *Gorski.*—Rubus frutic.
1826. *P. signata Pz.* (=P. bipunctata *F.*, cf. No. 1807), 1½ mm.—Clemat. recta, Thalictr. aquilegif., Res. lutea, Malva sylv., Arunc. sylv., Sedum album, Astrant. major, Aethusa Cyn., Knaut. arv., Matric. Cham., Verbasc. nigr., Polygon. Bist.
1827. P. sinuata *Schenck.*—Ruta graveol., Rosa pomif., Petrosel. sat., Aethusa Cyn., Aneth. grav., Dauc. Car., Cirs. arv., Hierac. Pilos.
1828. P. trimaculata *Schenck.*—Heracl. Sphond.
1829. P. variegata *F.*—Cist. monspel., Paliurus acul., Dorycn. herbac., Rubus frutic., Sedum acre, Sium latif., Oenan. aquat., Dauc. Car., Orlaya grand., Toril. Anthr., Achill. Millef., A. Ptarm., Tanac. corymb., Cirs. arv., Jas. mont.
1830. P. sp.—Alyss. mont., Res. lutea, Tilia ulmif., Geran. sanguin., Agrim. odor., Scleranthus annuus, Astrant. maj. var. involucr., Pimpin. Saxifr., Oenan. fist., Angel. sylv., Peuced. Cerv., P. ruthen., Gal. verum, Hypoch. radic., Hierac. bupleur., Beta marit., Euphorb. heliosc., Ornithog. pyren.
1831. Psithyrus barbutellus *K.*, ♀ 12 mm.—Acer Pseudoplat., Aesc. Pavia, Trif. rep. ♀ F+I+, Trif. prat. ♀ F+I+, T. med., Lotus corn., Philad. coron., Knaut. arv., K. sylv., Succ. prat., Scab. Columb., Tanac. vulg., Cirs. olerac., Card. crisp., C. nut., Centaur. Jac., Leont. aut., L. hast., Tarax. off., Syring. vulg., Lycops. arv., Echium vulg., Veron. off., Rhinanth. maj., Salv. off., Thym. Serp., Nepeta Glech. ♀ F+I+, Lam. alb. ♀ F+I+, Ajug. rept. F+I+, Teucr. Scorod. F+I+.
1832. P. barbutellus *K.* var. maxillosus *Klg.*—Lotus corn.
1833. P. campestris *Pz.*, ♀ 12 mm.—Trif. prat. ♀ F+I+, T. med., Onobr. viciif., Rubus frutic., Epil. angust., Lythr. Sal. F+I+, Sedum Teleph., Dipsac. sylv., Knaut. arv., Succ. prat., Scab. Columb., Eupat. can., Solidag. Virgaur., Helianth. an., Senec. Jacob., Cirs. lanceol., C. acaule × C. olerac., C. serrulat., Card. nut., Lappa toment., Centaur. Jac., Leont. crisp., Tarax. off., Vacc. Myrt., V. uligin., Call. vulg., Eric. Tetr., Anchusa off., Lycops. arv., Echium vulg., Mentha aquat., Thym. Serp., Lam. purp. F+I+, Prun. vulg. F+I+, Teucr. Scorod. F+I+, Iris sibir.
1834. P. campestris *Pz.* var. rossiellus *K.*—Cephal. ural.
1835. P. globosus *Eversm.*—Aconit. Nap., Vicia Cracca ♂ F+I+, Knaut. arv., Solidag. Virgaur., Cirs. spinosis.

1836. P. quadricolor *Lep.* ♀ and ♂ 9 mm.—Trif. rep. ♂ F+I+, Rubus frutic., Sedum album, Knaut. arv., Arnica mont., Senec. nemor., S. Jacob., Cirs. arv., C. pal., Centaur. Jac., Tarax. offic., Jas. mont., Veron. mont., Origan. vulg., Thym. Serp., Polygon. vivip., Salix Capr., S. nigric., S. glauca, S. lapp., S. phyllicif.

1837. P. quadricolor *Lep.* var. luctuosus *Hoffer.*—Knaut. arv.

1838. P. rupestris *F.*, ♀ 11–14 mm.—Coryd. lutea, Cak. marit., Trif. prat. ♀ F+I+, T. alp., T. rub., Lotus corn., Onobr. viciif., Rubus Id., Angel. sylv., Dipsac. sylv., Cephal. ural. var. cretac., Knaut. arv., Succ. prat., Eupat. can., E. purp., Solidag. Virgaur., Helianth. an., Helichrys. bract., Cirs. arv., C. lanceol., Card. crisp., C. nut., Onopord. Acanth., Carl. acaul., Centaur. Jac., C. Scab., C. rhen., C. orient., C. rigidif., Leont. aut., Tarax. off., Crep. bien., Hierac. umb., Campan. rot., Jas. mont., Vacc. uligin., Call. vulg., Anchus. off., Lycops. arv., Echium vulg., Melamp. nemor., Nepeta Glech. ♀ F+I+, Ball. nigr. ♀ F+I+, Leont. lanat., Teucr. Cham., T. canum.

1839. * P. vestalis *Fourcr.* 12 mm.—Cak. marit., Viola can., V. tric. vulg. ♀ F+I+, Coron. Fl.-cuc., Alth. ficif., Aesc. Pavia, Cytis. Lab. F+I+, Trif. rep. ♂ F+I+, T. prat. ♀ F+I+, Vicia Cracca ♂ F+I+, Rubus frutic., Crat. Oxyac., Epil. angust., Lythr. Sal. F+I+, Angel. sylv., Symphoric. racem. ♂ F+I+, Dipsac. sylv., Knaut. arv., Succ. prat., Eupat. can., E. purp., Vernon. fascic., V. praeal., Solidag. Virgaur., Silph. trifol., Inul. brit., Helian. atrorub., Senec. nemor., S. macroph., Cirs. arv., C. lanceol., C. pal., C. olerac., C. olerac. var. amar., C. olerac. × C. acaule, C. serrul., Card. crisp., Centaur. phryg., C. Scab., C. orient., S. stereoph., Leont. aut., Tarax. off., Hierac. hirsut., Vacc. Myrt., V. uligin., Syring. vulg., Vinca min., Gent. pneum., Lycops. arv., Echium vulg., Veron. off., Melamp. nemor., Mentha sylv., Salv. glutin., S. verticill., Monarda fistul., M. fistul. vars. mollis and purpur., Origan. vulg., Thym. Serp., Calam. Nepeta, Nepeta macr. ♂ F+I+, N. lophantha, N. Glech. ♀ F+I+, Lophanth. rug., Lam. alb. ♀ F+I+, Stach. pal. F+I+, S. germ. F+I+, Teucr. Scorod. F+I+, T. canum, Polygon. vivip., Salix cin., S. Capr., S. aurit., S. alba, S. fragil., S. rep., S. nigric., S. glauca, S. lapp., S. phyllicif., Iris Pseudac. F+I+.

1840. Rophites canus *Ev.*—Malva Alcea, Medic. sat. ♂ F+I+, M. falc., Trif. prat. ♀ and ♂ F+I+, Lotus corn. ♀ and ♂, ? F+I+.

1841. R. caucasicus *Mor.*—Stachys grandifl.

1842. *R. halictula Nyl.* (=Dufourea halictula *Nyl.*, cf. No. 1474).—Jas. mont.

1843. R. quinquespinosus *Spin.*—Achill. Millef., A. Ptarm., Anthem. tinct., Centaur. nigr., Campan. pat., Echium vulg., Galeops. ochr. F±I+, Stachys Beton. F+I+, Ball. nigr. ♀ and ♂ F+I+.

1844. *Saropoda bimaculata Pz.* (=Podalirius bimaculatus *Pz.*, cf. Nos. 1780 and 1845), 9 mm.—Hyper. perfor., Trif. arv. ♂ F+I+, Onopord. Acanth., Centaur. Jac., C. Cyan., Call. vulg., Echium vulg., Salv. verticill. ♂ F+I+, Origan. vulg., Thym. Serp., Stach. pal. ♀ and ♂ F+I+, S. Beton. ♀ and ♂ F+I+, Marrub. vulg. ♂ F+I+, Ball. nigr. F+I+, Teucr. Scorod. F+I+, T. Scord.

1845. * *S. rotundata Pz.* (=Podalirius bimaculatus *Pz.*, cf. Nos. 1780 and 1844).—Vicia angustif. F+I+, Lythr. Sal. ♀ and ♂ F+I+, Centaur. rhen., Jas. mont., Anchusa off., Echium vulg., Thym. Serp., Ball. nigr. F+I+.

1846. Sphecodes affinis *Hags.*—Matric. inod.

1847. *S. cirsii Verh.* (=S. fuscipennis *Germ.*, cf. No. 1849).—Achill. Millef., Cirs. arv.

1848. S. ephippius *L.* (cf. No. 1851).—Teesdal. nudicaul., Gypsoph. panic., Aren. serpyllif., Cerast. semidec., Erod. cicut., Chaeroph. hirs., Bellis per., Diplopap. amygd., Solidag. glab., Gnaph. lut.-alb., G. ulig., Tanac. vulg., Chrys. Leuc., Doronic. austriac., Cirs. arv., Call. vulg., Salix sp.

1849. S. fuscipennis *Germ.* (cf. No. 1847).—Ajug. rept. F±I+, Teucr. Botrys.

1850. S. gibbus *L.*—Stell. med., Geran. pyren., Ruta graveol., Paliur. acul., Doryen. herbac., Potent. Anser., P. rept., Alchem. alp., A. fissa, A. pentaphyllea, Spir. sorbif., S. salicif., S. ulmif., Epil. angust., Sedum acre, Ribes alp., Astrant. neglecta, Petrosel. sat., Pimpin. Saxifr., Oenan. aquat., Aneth. grav., Heracl. Sphond., Dauc. Car., Ebul. humil., Valer. off., Valerian. olit., Aster sagittif., Bellis per., Solidag. canad., Gnaph. lut.-alb., Achill. Millef., A. Ptarm., A. nobilis, Matric. Cham., Tanac. vulg., Chrys. Leuc., Doronic. austr., Cirs. arv., Leont. aut., Hypoch. radic., H. glabra, Tarax. off., Hierac. Pilos., H. umbell., Call. vulg., Myosot. interm., Veron. Cham., V. arv.,

Mentha sylv., Thym. Serp., Euphorb. Cypar., Salix cin., S. Capr., S. aurit., Scilla marit.

1851. *S. gibbus L. var. rufescens Fourcr.* (=S. ephippius *L.*, cf. No. 1848).—Jas. mont., Salix sp.
1852. S. similis *Wesm.*—Oxytrop. camp., Astrag. Onobr.
1853. S. subquadratus *Sm.*, ♀ 3 mm.—Paliur. acul., Dorycn. herbac.
1854. S. sp.—Coryd. cava F±I+, Bellis per.
1855. Stelis aterrima *Pz.*, 5–5½ mm.—Malva sylv., Geran. prat., Trif. rep. F+I+, Knaut. arv., Scab. dauc., Inula Hel., Doronic. austriac., Cirs. lanceol., Card. crisp., C. acanth., Onopord. Acanth., Lappa min., Rhapont. pulch., Tarax. off., Lactuca vimin., Sonchus asp., Crep. vir., Hierac. porphyr., Jas. mont., Asclep. syr. F+I+, Conv. sep.
1856. S. breviuscula *Nyl.* (=*S. pygmaea Schenck*).—Geran. prat., Rubus frutic., R. caes., Potent. arg., Petrosel. sat., Knaut. arv., Inula hir., Achill. Millef., A. Ptarm., Tanac. vulg., Senec. Jacob., Card. acanth., Centaur. Cyan., Picr. hierac., Crep. bien., Echium vulg.
1857. S. frey-gessneri *Friese.*—Centaur. vales.
1858. S. minuta *Lep.*—Malva sylv., Geran. prat., Tarax. off.
1859. S. nasuta *Latr.*—Stach. recta, Ajug. rept., Teucr. mont.
1860. S. ornatula *Klg.*—Picr. hierac.
1861. S. phaeoptera *K.*—Malva sylv., Geran. prat., G. pyren., G. Robert., Knaut. arv., Inula Hel., Doronic. austriac., Senec. Doronic., S. nemor., Silyb. Marian., Card. acanth., Onopord. Acanth., Centaur., Mont., C. Fischer., Mulged. alpin., Crep. bien., C. sibiric., Campan. rot., Echium vulg., Veron. longif.
1862. S. signata *Latr.*—Res. odor., Sedum refl., Sedum album.
1863. S. sp.—Lathyr. latif.
1864. Systropha curvicornis *Scop.* (cf. No. 1866).—Linum grandifl., Melilot. albus F+I+, Conv. arv.
1865. S. planidens *Gir.*—Conv. arv.
1866. *S. spiralis F.* (=S. curvicornis *Scop.*, cf. No. 1864).—Conv. arv.
1867. *Tetralonia pollinosa Lep.* (=Eucera pollinosa *Lep.*, cf. No. 1513).—Anchusa off.
1868. *T. salicariae Lep.* (=Eucera salicariae *Lep.*, cf. Nos. 1491 and 1516).—Ball. nigr. ♂ F+I+.
1869. Trachusa serratulae *Pz.* (=Diphysis serratulae *Pz.*, cf. No. 1472).—Ran. Flamm., Genista sagitt., Lotus corn. F+I+, Lathyr. sylvest. ♀ F+I+, Leont. aut., Campan. Trach.
1870. *Trypetes truncorum L.* (=Eriades truncorum *L.*, cf. Nos. 1487 and 1606).—Tarax. off.
1871. Xylocopa cyanescens *Brull.*—Parkinsonia acul., Dorycn. herbac., Coron. var. F+I+, Veron. spic., Rosmar. off., Nepeta Glech. hed. F+I+.
1872. X. valga *Gerst.*—Veron. spic.
1873. X. violacea *L.*—Clemat. Balear., Berb. aquif., Glaucium flavum, Matth. annua, Cheiranth. Cheiri, Raphan. sat., Polyg. myrtif., Spart. junc., Medic. sat. ♂ F+I+, Coron. Emerus, Onobr. viciif., Lathyr. prat. ♀ F+I+, L. latif., L. varieg., Glycine chin. ♀ and ♂ F+I+, Amygd. comm., Persica vulg., Prunus Armen., Ulmar. pentap., Passifl. coerul. F+I+, Helianth. an., Helichrys. bract., Chrys. Leuc., Centaur. aren., Campan. Trach., Phillyr. latif., Syring. vulg., Symphyt. off., Veron. spic., Salv. prat., S. glutin. ? F+I+, S. off. ♂ F+I+, Nepeta Glech. hed. F+I+, Lam. alb. ♀ and ♂ F+I+, L. Galeobd., Marrub. candidiss., Ajug. rept., Cyclam. persic., Salix sp., Croc. varieg., Gladiol. comm., Hermodact. tuber. F+I+.
1874. X. sp.—Lathyr. silvest. F+I+.

B. Braconidae.

1875. Agathis umbellatorum *Nees.*—Aneth. grav.
1876. Alysia sp.—Listera ov. F+I+.
1877. *Bracon castrator F.* (=Pseudovipio castrator *F.*).—Paliur. acul., Lonicer. etrusc.
1878. *B. nominator F.* (=Vipio nominator *F.*).—Paliur. acul.
1879. *B. terrefactor Vill.* (=Vipio terrefactor *Vill.*).—Paliur. acul., Dorycn. herbac.
1880. B. urinator *F.*—Paliur. acul., Smyrnium Olusatrum, Tordyl. apul.
1881. B. xanthogaster *Krchb.*—Paliur. acul.

1882. Isomecus schlettereri *Kriechb.*—Paliar. acul.
1883. *Microgaster rufipes Nees* (=M. globata *L.* var. rufipes *Nees*).—Listera ov. F+I+.
1884. M. subcompleta *Nees.*—Paliur. acul.
1885. M. tibialis *Nees.*—Paliur. acul.
1886. M. sp.—Anthr. sylv.

C. Chalcididae.

1887. *Brachymeria minuta L.* (=Chalcis minuta *L.*).—Paliur. acul.
1888. Chalcis sp.—Prunus Armen., Saussur. albesc.
1889. Eulophus sp.—Adoxa Mosch.
1890. *Leucospis dorsigera F.* (=Leucaspis dorsigera *F.*).—Paliur. acul., Dorycn. herbac., Petrosel. sat.
1891. L. gigas *F.*—Dorycn. herbac., Teucr. Pol.
1892. L. intermedia *Ill.*—Paliur. acul., Dorycn. herbac.
1893. Perilampus sp.—Salix cin., S. Capr., S. aurit.
1894. Pteromalus *sp.*—Erod. cicut., Carum Carv., Adoxa mosch.
1895. Tetrastichus diaphanthus *Walk.*—Hermin. Monorch.
1896. Torymus sp.—Anthr. sylv.

D. Chrysididae.

1897. Chrysis analis *Spin.*—Euon. japon., Pastin. sat., Centaur. Jac., Origan. vulg.
1898. C. angustifrons *Ab.*—Tordyl. apul.
1899. C. austriaca *F.*—Heracl. Sphond., Ribes rubr.
1900. *C. bidentata L.* (=C. viridula *L.*).—Euon. varieg., Aneth. grav.
1901. C. callimorpha *Mocs.*—Dauc. Car.
1902. C. chevrieri *Mocs.*—Paliur. acul.
1903. C. comparata *Lepel.*—Euon. japon.
1904. C. cuprea *Rossi.*—Orlaya grand.
1905. C. dichroa (*Klg.*) *Dahlb.*—Potent. Wiemanniana.
1906. C. distinguenda *Spin.*—Euon. japon., E. varieg., Foenic. vulg., Allium Cepa.
1907. C. fulgida *L.*—Dauc. Car., Ribes rubr.
1908. C. ignita *L.*—Cak. marit., Ruta graveol., Ulmar. pentap., Archang. off., Heracl. Sphond., Chaeroph. hirs., Euphorb. Cypar.
1909. C. ignita *L.* v. angustula *Schenck.*—Anthr. sylv.
1910. C. igniventris *Ab.*—Paliur. acul.
1911. C. inaequalis *Dhlb.*—Euon. japon., E. varieg., Paliur. acul., Tordyl. apul., Dauc. Car.
1912. C. indigotea *Duf. et Perr.*—Paliur. acul.
1913. C. jucunda *Mocs.*—Paliur. acul.
1914. C. leachii *Schuck.*—Euon. japon., E. varieg.
1915. C. neglecta *Schuck.*—Achill. Millef.
1916. C. pustulosa *Ab.*—Paliur. acul.
1917. C. refulgens *Spin.*—Paliur. acul., Orlaya grand.
1918. C. rutilans *Oliv.*—Euon. japon., Eryng. camp., Orlaya grand., Allium Cepa.
1919. C. saussurei *Chevr.*—Pimpin. Saxifr.
1920. C. scutellaris *Fabr.*—Euon. japon., E. varieg., Foenic. vulg., Orlaya grand.
1921. C. splendidula *Rossi.*—Euon. japon., Paliur. acul., Dauc. Car.
1922. C. succincta *L.*—Paliur. acul., Dauc. Car., Cauc. dauc.
1923. C. viridula *L.*—Euon. japon., Aneth. grav., Dauc. Car., Orlaya grand.
1924. C. sp.—Eryng. camp.
1925. Cleptes nitidulus *F.*—Dauc. Car., Lycium vulg.
1926. C. semiauratus *L.*—Heracl. Sphond., Eupat. can., Echium vulg.
1927. Ellampus aeneus *F.*—Berb. vulg., Prunus Padus, Sambuc. nigr., Euphorb. Cypar.
1928. E. auratus *L.*—Ulmar. pentap., Tordyl. apul., Orlaya grand., Toril. nod.
1929. E. caeruleus (*Pall.*) *Dahlb.*—Euon. japon., Heracl. Sphond.
1930. *E. productus Dahlb.* (=E. spina *Lep.*, cf. No. 1932).—Allium Cepa.
1931. E. scutellaris *Pz.*—Dauc. Car.
1932. E. spina *Lep.* (cf. No. 1930).—Paliur. acul., Allium Cepa.
1933. Hedychrum longicolle *Ab.*—Tordyl. apul.
1934. *H. lucidulum F.* (=H. nobile *Scop.*, cf. No. 1935).—Spir. sorbif., S. salicif., S. ulmif., Aegop. Podagr., Peuced. Cerv., Aneth. grav., Dauc. Car., Achill.

Millef., A. Ptarm., Matric. inod., Tanac. Corymb., Senec. Jacob., Cirs. arv., Hierac. umbell., Jas. mont., Melamp. arv., Marrub. vulg. F±I±.

1935. H. nobile *Scop.* (cf. No. 1934).—Lepid. sat., Euon. japon., Rubus frutic., Ulmar. pentap., Eryng. camp., Achill. Millef.
1936. *H. regium F.* (=A. nobile *Scop.*).—Orlaya grand., Achill. Millef.
1937. *H. roseum Rossi.* (=Holopyga rosea *Rossi*, cf. No. 1945).—Foenic. vulg.
1938. H. rutilans *Dhlb.*—Euon. japon., Pastin. sat.
1939. Holopyga amoenula *Dahlb.* (cf. No. 1944).—Erod. cicut., Paliur. acul., Cirs. arv., Card. pycnocephal.
1940. H. chrysonota *Foerst.*—Euon. japon., Paliur. acul.
1941. H. coriacea *Dahlb.*—Scleranth. per.
1942. H. curvata *Foerst.*—Paliur. acul., Dauc. Car.
1943. H. gloriosa *F.*—Paliur. acul.
1944. *H. ovata Dahlb.* (=H. amoenula *Dahlb.*, cf. No. 1939).—Potent. Anser., Gal. verum.
1945. H. rosea *Rossi* (cf. No. 1937).—Euon. japon., E. varieg.
1946. Parnopes grandior *Pall.*—Thym. Serp., Allium Cepa.
1947. Stilbum cyanurum *Foerst.* var. calens *Fabr.*—Foenic. vulg., Orlaya grand.
1948. *S. nobile Sulz.* (=S. cyanurum *Forst.* var. nobile *Sulz.*).—Euon. japon.

E. Cynipidae.

1949. Blastophaga grossorum *Grav.*—Sycom. antiqu. F+I+.
1950. Eucoela subnebulosa *Gir.*—Anthr. sylv.
1951. E. sp.—Stell. med., Chrysosplen. alt.
1952. Sycophaga sycomori *L.* (*Hasselquist*).—Sycom. antiqu. F+I+.

F. Evanidae.

1953. *Foenus affectator F.* (=Gasteruption affectator *F.*, cf. No. 1956).—Potent. arg., Aegop. Podagr., Angel. sylv., Aneth. grav., Chaeroph. hirs.
1954. *F. jaculator F.* (=Gasteruption jaculator *F.*, cf. No. 1958).—Aegopod. Podagr., Aneth. grav.
1955. *F. sp.* (=Gasteruption sp.).—Spir. sorbif., S. salicif., S. ulmif., Petrosel. sat., Heracl. Sphond., Diplopap. amygd., Achill. Millef., A. Ptarm., Tanac. Parth., Jas. mont., Melamp. arv.
1956. Gasteruption affectator *F.* (cf. No. 1953).—Ruta graveol., Paliur. acul.
1957. G. granulithorax *Tourn.*—Paliur. acul., Smyrn. olusat., Pimpin. peregr., Tordyl. apul., Orlaya grand.
1958. G. jaculator *F.* (cf. No. 1954).—Gypsoph. panic., Ruta graveol.
1959. G. kriechbaumeri *Schlett.*—Paliur. acul., Cauc. dauc.
1960. G. opacum *Tourn.*—Paliur. acul.
1961. G. pedemontanum *Tourn.*—Paliur. acul., Dorycn. herbac.
1962. G. rubricans *Guer.*—Paliur. acul., Dorycn. herbac.
1963. G. rugulosum *Ab.*—Smyrn. olusat.
1964. G. terrestre *Tourn.*—Paliur. acul., Tordyl. apul.
1965. G. tibiale *Tourn.*—Paliur. acul., Dorycn. herbac.
1966. G. tournieri *Schlett.*—Paliur. acul.

G. Formicidae.

1967. Genus et sp. ?—Asclep. syr. F−I+, Anchusa off., Salv. glut. ? F−I−.
1968. *Formica congerens Nyl.* (=F. pratensis *Deg.*, cf. No. 1971).—Adon. vern., Tarax. off.
1969. F. exsecta *Nyl.*—Serrat. lycopif.
1970. F. fusca *L.*—Ranunc. rep., R. Fic., Potent. Anser., P. steril., Parnass. palust., Carum Car., Dauc. Car., Tussil. Farf., Solidag. canad., Cirs. arv., Call. vulg., Linar. vulg., Veron. hederif., Antheric. ramos.
1971. F. pratensis *Deg.* (cf. No. 1968).—Rubus frutic., Potent. verna, Sorbus Auc.
1972. F. rufa *L.*—Medic. falc., Sorbus Auc., Salix fragil.
1973. F. rufibarbis *F.*—Serrat. lycopif.
1974. F. sp.—Rubus frutic., Parn. pal., Euphorb. dendroid.
1975. Lasius alienus *Foerst.*—Pulsat. vulg. F±I+, Serrat. centaur.
1976. L. brunneus *Latr.*—Myrrhis odor.
1977. L. fuliginosus *Ltr.*—Veron. Cham., Salix cin., S. Lapr., S. aurit.
1978. L. niger *L.*—Ranunc. acris, R. rep., R. bulc., Berb. vulg., Res. lutea, Stell. gramin., S. med., Potent. Anser., Spir. sorbif., S. salicif., S. ulmif., Pyrus comm., Philad. coron., Scleranth. per., Chrysosplen. alt. F±I+, Parnass.

palust., Carum Car., Anthr. sylv., Prangos ferul., Serrat. lycopif., Tarax. off., Conv. arv., Veron. Anag., Gagea stell., Antheric. ramos., Allium rot.

1979. Leptothorax interruptus *Schenck.*—Pulsat. vulg. F±I+.
1980. Myrmica levinodis *Nyl.*—Pulsat. vulg. F±I+, Fragaria vesca, Spir. sorbif., S. salicif., S. ulmif., Herniaria glabra, Chrysospl. alt., Carum Car., Bellis per., Asclep. syr. F−I−.
1981. M. rubra *L.*—Parnass. palust., Dauc. Car., Gal. Moll., Succ. prat., Eupat. can., Senec. Jacob., Narth. ossifr.
1982. M. ruginodis *Nyl.*—Pulsat. vulg. F±I+, Chrysosplen. alt.
1983. M. rugulosa *Nyl.*—Carum Car., Gal. Moll.
1984. M. scabrinodis *Nyl.*—Pulsat. vulg. F±I+.
1985. M. sp.—Sorbus Auc., Lathr. Squam.
1986. Tapinoma erraticum *Latr.*—Pulsat. vulg. F±I+.

H. Ichneumonidae.

1987. Genus et sp.—Veron. hederif., Mentha aquat., Thym. Serp., Salix cin., S. aurit., S. Capr., Narth. ossifr.
1988. Acoenites fulvicornis *Gr.*—Toril. nod.
1989. Alomya ovator *F.*—Anthr. sylv.
1990. *Amblyteles armatorius Foerst.* (=A. fasciatorius *F.*).—Paliur. acul., Tordyl. Apul., Anthr. sylv.
1991. A. fossorius *Müll.*—Pastin. sat.
1992. A. funereus *Fourcr.*—Heracl. Sphond.
1993. A. fuscipennis *Wesm.*—Pastin. sat., Heracl. Sphond.
1994. A. laminatorius *F.*—Sium latifol.
1995. A. litigiosus *Wesm.*—Lepid. graminifol.
1996. A. negatorius *F.*—Liban. mont.
1997. A. occisorius *F.*—Angel. sylv.
1998. A. oratorius (*F.*) *Wesm.*—Dauc. Car.
1999. A. palliatorius *Gr.*—Liban. mont.
2000. A. repentinus *Gr.*—Dauc. Car.
2001. A. sputator (*F.*) *Wesm.*—Pastin. sat.
2002. A. unigattatus *Grav.*—Listera ov. F+I+.
2003. Angitia armillata *Gr.* (=Limneria armillata *Gr.*).—Pimpin. Peregr., Tordyl. apul.
2004. Anilasta notata *Gr.*—Limneria notata *Gr.*—Tordyl. apul.
2005. A. rapax (*Gr.*) *Ths.*—Sedum acre.
2006. Anisobas sp.—Toril. nod.
2007. Banchus falcator *F.*—Angel. sylv., Salix alba, S. fragil.
2008. Bassus laetatorius *F.*—Cheiranth. Cheiri, Laur. nob.
2009. *B. tarsatorius Pz.* (=Homotropus tarsatorius *Pz.*).—Cheiranth. Cheiri, Lycop. europ.
2010. Caenocryptus bimaculatus *Grav.*—Liban. mont.
2011. Campoplex oxyacanthae *Boie.*—Chaeroph. tem.
2012. C. sp.—Prangos ferul., Listera ov. F+I+.
2013. Casinaria tenuiventris *Gr.*—Paliur. acul.
2014. Colpognathus celerator *Gr.*—Orlaya grand.
2015. Crypturus argiolus *Rossi.*—Paliur. acul.
2016. *Cryptus analis Gr.* (=Idiolispa analis *Gr.*).—Medic. falc.
2017. Cryptus bucculentus *Tschek.*—Paliur. acul.
2018. C. hellenicus *Schmiedek.*—Tordyl. apul.
2019. C. viduatorius *F.*—Paliur. acul., Tordyl. apul.
2020. C. sp.—Listera ov. F+I+.
2021. Exenterus apiarius (*Gr.*) *Thoms.* (=*Tryphon apiarius Gr.*).—Pastin. sat.
2022. Exephanes hilaris *Wesm.*—Paliur. acul.
2023. Exetastes guttatorius *Gr.* var. procera *Krchb.*—Paliur. acul.
2024. Exochus gravipes *Gr.*—Pastin. sat.
2025. Exyston cinctulus *Gr.*—Heracl. Sphond.
2026. Glypta ceratites *Gr.*—Paliur. acul.
2027. G. fronticornis *Gr.*—Parnass. palust.
2028. G. incisa *Gr.*—Heracl. Sphond.
2029. G. pictipes *Taschenb.*—Toril. infesta.
2030. *Gravenhorstia picta Boie.* (=Anomalon fasciatum *Gir.*).—Lonic. implexa.
2031. Hellwigia elegans *Gr.*—Dauc. Car.

2032. Hemiteles septentrionalis *Holmgr.*—Cerast. alp., Dryas octopet., Saxif. caespit.
2033. H. sp.—Listera ov. F+I+.
2034. Hoplismenus armatorius *Pz.*—Paliur. acul.
2035. Holocryptus heliophilus *Tschek.*—Tordyl. apul.
2036. Ichneumon balteatus *Wesm.*—Paliur. acul.
2037. I. bilunuatus *Gr.*—Tordyl. apul.
2038. I. consimilis *Wesm.*—Paliur. acul.
2039. I. extensorius *L.*—Anthr. sylv.
2040. I. fabricator *F.*—Anthr. sylv.
2041. I. finitimus *Tischb.* (=*I. intermixtus Tischb.*).—Tordyl. apul.
2042. I. gradarius *Wesm.*—Heracl. Sphond.
2043. I. leucomelas (*Gr.*) *Wesm.*—Dauc. Car.
2044. I. monostagon *Gr.*—Paliur. acul.
2045. I. pisorius *Gr.*—Paliur. acul.
2046. I. sarcitorius *L.*—Paliur. acul., Liban. mont., Salix alba, S. fragil.
2047. I. similatorius (*F.*) *Thoms.* (=*Amblyteles gigantorius Hgr.*).—Pastin. sat., Dauc. Car.
2048. I. suspiciosus *Wesm.*—Salix alba, S. fragil.
2049. I. xanthorius *Forst.*—Tordyl. apul., Orlaya grand.
2050. I. sp.—Ranunc. Fic., Cochlear. off., Cerast. arv., Malva sylv., Ruta graveol., Parnass. pal., Conium macul., Tussil. Farf., Bellis per., Leont. Aut., Tarax. off., Salix vimin., S. Capr.
2051. Limneria (Angitia) chrysosticta *Gr.*—Paliur. acul.
2052. L. (Angitia) fenestralis *Ths.*—Anthr. Ceref.
2053. *Linoceras macrobatus Gr.* (=Hosprhynchotus macrobatus *Gr.* var. geniculata *Krchb.*).—Paliur. acul., Pimpin. peregr.
2054. Lissonota commixta *Hgr.*—Parnass. pal.
2055. L. folii *Ths.*—Paliur. acul.
2056. L. maculatoria (*Gr.*) *F.*—Dauc. Car.
2057. L. verberans *Gr.* var. procera *Kriechb.*—Paliur. acul.
2058. Mesoleius cruralis *Gr.*—Pimpin. peregr., Cauc. dauc.
2059. Mesostenus grammicus *Gr.*—Paliur. acul.
2060. M. grammicus *Gr.* var. nigroscutellatus *Kriechb.*—Paliur. acul.
2061. M. ligator *Gr.*—Rubus Id.
2062. Metopius dentatus *F.*—Paliur. acul.
2063. M. micratorius *Gr.*—Angel. sylv., Heracl. Sphond.
2064. Microcryptus curvus (*Grav.*) *Thoms.*—Dauc. Car.
2065. Onorga mutabilis *Hgr.* (=*Limneria mutabilis Hgr.*).—Paliur. acul., Tordyl. apul.
2066. Ophion (Henicospilus) ramidulus *Gr.*—Angel. sylv.
2067. O. (Henicospilus) undulatus *Gr.*—Paliur. acul.
2068. Orthocentrus pedestris *Holmgr.*—Cerast. alp., Dryas octopet., Saxif. caespit.
2069. Perithous mediator *F.*—Colutea arbor.
2070. Pezomachus sp.—Stell. med., Adoxa Mosch.
2071. Phygadeuon cephalotes *Gr.*—Angel sylv.
2072. P. (Campoplex) nitens *Gr.*—Paliur. acul.
2073. P. sp.—Listera ov. F+I+.
2074. Pimpla examinator *F.*—Anthr. sylv.
2075. P. illecebrator *Rossi.*—Paliur. acul.
2076. P. inquisitor *Scop.*—Lam. mac.
2077. P. instigator (*F.*) *Gr.*—Paliur. acul., Tordyl. apul.
2078. P. roberator *F.*—Tordyl. apul.
2079. P. turionellae *L.*—Paliur. acul.
2080. P. vesicaria *Ratzeb.*—Paliur. acul.
2081. Platylabus pedatorius *F.*—Satureia mont.
2082. Pristomerus luteus *Pz.*—Res. lutea.
2083. P. vulnerator *Gr.*—Paliur. acul.
2084. Sagaritis annulata *Gr.*—Paliur. acul.
2085. S. annulata *Gr.* var. fuscicarpus *Krchb.*—Paliur. acul.
2086. Spilocryptus claviventris *Krchb.*—Paliur. acul.
2087. Stylocryptus vagabundus (*F.*) *Grav.*—Heracl. Sphond.
2088. Trachynotus foliator *F.*—Paliur. acul., Ammi maj.
2089. Trichomma enecator *Rossi.*—Paliur. acul.

2090. Trychosis plebejus *Tschek.* var. nigritarsis *Krchb.*—Paliur. acul., Tordyl. apul.
2091. Tryphon elongator (*F.*) *Gr.*—Pastin. sat.
2092. T. rutilator *Gr.*—Coron. Fl.-cuc., Oenan. fist.
2093. T. trochanteratus *Hgr.*—Anthr. sylv.
2094. T. sp.—Listera ov. F+I+.

I. Mutillidae.

2095. Methoca ichneumonides *Latr.*—Aegop. Podagr.
2096. Mutilla europaea *L.*—Pastin. sat., Dauc. Car.
2097. M. melanocephala *F.* (=*Myrmosa melanocephala F.*, cf. No. 2100).—Aegop. Podag., Aneth. grav., Pastin. sativ.
2098. M. rufipes *F.* var. nigra *Rossi.*—Pastin. sat., Heracl. Sphond., Dauc. Car.
2099. M. viduata *Pall.*—Vicia villosa var. varia.
2100. *Myrmosa melanocephala F.* (=Mutilla melanocephala *F.*, cf. No. 2097).—Aegop. Podagr., Heracl. Sphond., Dauc. Car., Jas. mont.

K. Pompilidae.

2101. Agenia erythropus *Kohl.*—Dorycn. herbac.
2102. A. hircana *F.*—Aegop. Podagr.
2103. A. variegata *L.*—Paliur. acul.
2104. *Calicurgus fasciatellus Spin.* (=Salius hyalinatus *F.*, cf. No. 2146).—Heracl. Sphond.
2105. Ceropales albicinctus *Rossi.*—Melamp. arv.
2106. C. maculatus *F.*—Aegop. Podagr., Pimpin. Saxifr., Oenanth. aquat., Selinum carvif., Angel. sylv., Peuced. Cerv., Heracl. Sphond., Dauc. Car., Toril. Anthr., Gnaph. lut.-alb., Achill. Millef., A. Ptarm., Tanac. vulg., Carl. vulg., Jas. mont.
2107. Ceropales variegatus *F.*—Paliur. acul., Peuced. Cerv., Heracl. Sphond., Dauc. Car.
2108. Pompilus abnormis *Dahlb.*—Heracl. Sphond.
2109. P. anceps *Sm.*—Heracl. Sphond.
2110. *P. aterrimus Rossi* (=P. samariensis *Pall.*).—Paliur. acul.
2111. *P. cellularis Dahlb.* (=P. minutus *Dahlb.*, cf. Nos. 2119 and 2120).—Paliur. acul.
2112. P. chalybeatus *Schjödte.*—Cak. marit., Achill. Millef., A. Ptarm.
2113. P. cinctellus *Spin.*—Aneth. grav.
2114. P. cingulatus *Rossi.*—Paliur. acul.
2115. P. concinnus *Dhlb.*—Aethusa Cyn.
2116. P. gibbus *F.* (cf. No. 2130).—Conium macul., Aegop. Podagr.
2117. P. intermedius *Schenck.*—Dauc. Car.
2118. P. latebricola *Kohl.*—Paliur. acul.
2119. P. minutus *Dahlb.* (=*P. cellularis Dahlb.*, cf. Nos. 2111 and 2120).—Spir. sorbif., S. salicif., S. ulmif., Aegop. Podagr., Tordyl. apul.
2120. *P. neglectus Dahlb.* (=P. minutus *Dahlb.*, cf. Nos. 2111 and 2119).—Aneth. grav., Heracl. Sphond., Dauc. Car., Anthr. sylv.
2121. *P. niger F.* (=P. nigerrimus *Scop.*).—Dauc. Car., Solidag. canad.
2122. P. nigerrimus *Scop.*—Paliur. acul., Aegop. Podagr., Heracl. Sphond.
2123. P. pectinipes *v.d. L.*—Heracl. Sphond., Dauc. Car., Anthr. Ceref., Chaeroph. tem., C. hirs.
2124. P. plumbeus *F.*—Cak. marit., Achill. Millef., A. Ptarm.
2125. P. quadripunctatus *F.*—Paliur. acul., Dorycn. herbac., Heracl. Sphond.
2126. P. rufipes *L.*—Cist. salviif., Achill. Millef., A. Ptarm., Jas. mont.
2127. P. sexmaculatus *Spin.*—Tordyl. apul.
2128. P. spissus *Schjödte.*—Aegop. Podagr., Anthr. Ceref., Chaeroph. tem.
2129. P. tripunctatus *Dahlb.*—Orlaya grand.
2130. *P. trivialis Dahlb.* (=P. gibbus *F.*, cf. No. 2116).—Oenan. aquat., Heracl. Sphond., Achill. Millef., A. Ptarm., Polygon. Fagop.
2131. P. unicolor *Spin.*—Heracl. Sphond.
2132. P. ursus *F.*—Paliur. acul.
2133. P. vagans (*Klug.*) *Costa.*—Paliur. acul.
2134. P. viaticus *L.* (=*P. fuscus L.*).—Paliur. acul., Parn. pal., Oenan. aquat., Silaus prat., Peuced. Cerv., Aneth. grav., Heracl. Sphond., Tordyl. apul., Dauc. Car., Anthr. sylv., Gnaph. lut.-alb., Achill. Millef., A. Ptarm., Sneec. Jacob., Leont. aut., Crep. tector., Jas. mont., Veron. Cham., Thym. dalm., Hott. pal., Euphorb. Cypar.

2135. P. wesmaëli *Thoms.*—Dauc. Car.
2136. P. sp.—Cornus sang.
2137. *Priocnemis bipunctatus F.* (=Salius versicolor *Scop.*, cf. No. 2154).—Peuced. Cerv.
2138. *P. obtusiventris Schjödte* (=Salius obtusiventris *Schjödte*, cf. No. 2150).—Peuced. Cerv., Dauc. Car.
2139. *P. pusillus Schjödte* (=Salius pusillus *Schjödte*).—Dauc. Car.
2140. Pseudagenia albifrons *Dalm.*—Res. lutea, Paliur. acul.
2141. P. carbonaria *Scop.*—Ruta graveol., Paliur. acul., Dorycn. herbac., Aegop. Podagr., Heracl. Sphond., Dauc. Car., Orlaya grand., Helianth. an.
2142. Salius affinis v.d. *L.*—Paliur. acul., Dauc. Car.
2143. S. elegans *Spin.*—Paliur. acul.
2144. S. exaltatus *F.*—Heracl. Sphond., Dauc. Car., Senec. Jacob.
2145. S. fuscus *F.* (cf. No. 2153.—Paliur. acul., Tordyl. apul., Orlaya grand., Euphorb. heliosc., E. Cypar.
2146. S. hyalinatus *F.* (cf. No. 2104).—Aegop. Podagr., Pastin. sat.
2147. S. minutus *v.d. L.*—Jas. mont.
2148. *S. notatus Lep.* (=? S. notatus *Rossi*).—Res. lutea, Heracl. Sphond., Senec. Jacob.
2149. S. notatus *Rossi.*—Aegop. Podagr., Heracl. Sphond., Dauc. Car.
2150. S. obtusiventris *Schjödte* (cf. No. 2138).—Heracl. Sphond.
2151. S. parvulus *Dahlb.*—Tordyl. apul.
2152. *S. sanguinolentus F.* (=Pompilus sanguinolentus *F.*).—Cirs. arv.
2153. *S. sepicola Sm.* (=S. fuscus *F.*, cf. No. 2145).—Ranunc. Fic., Aegopod. Podagr.
2154. S. versicolor *Scop.* (cf. No. 2137).—Eryng. camp., Pastin. sat.

L. Sapygidae.

2155. Sapyga clavicornis *L.*—Chaeroph. tem., Chrys. Leuc.
2156. S. quinquepunctata *F.*—Myosot. pal.

M. Scoliidae.

2157. Myzine tripunctata *Rossi.*—Paliur. acul., Dorycn. herbac.
2158. *Scolia bicincta Rossi* (=S. hirta *Schr.*, cf. No. 2162).—Cirs. arv., Asclep. syr.
2159. S. flavifrons *F.* (=*S. hortorum Cyr.*).—Asclep. syr. F+I+.
2160. S. flavifrons *F.* var. haemorrhoidalis *F.*—Anthyll. Vuln. F+I+.
2161. *S. haemorrhoidalis F.* (=S. flavifrons *F.* var. haemorrhoidalis *F.*).—Thym. dalm., Teucr. Cham.
2162. S. hirta *Schr.* (cf. No. 2158).—Dorycn. herbac., Hedera Hel., Helichrys. ang., Asclep. syr. F+I+, Myosot. hisp., Satureia mont., Thym. Serp., T. dalm., Teucr. Pol., Polygon. Fagop.
2163. S. insubrica *Scop.*—Dorycn. herbac., Orlaya grand., Helichrys. ang., Card. nut., Teucr. Pol.
2164. S. quadripunctata *F.*—Dorycn. herbac., Dauc. Car., Orlaya grand., Asclep. syr. F+I+, Thym. Serp., Teucr. Pol.
2165. S. quinquecincta *F.*—Teucr. Pol.
2166. Tiphia femorata *F.*—Cak. marit., Paliur. acul., Parnass. palust., Eryng. camp., Conium macul., Peuced. Cerv., Aneth. grav., Pastin. sat., Heracl. Sphond., Tordyl. apul., Dauc. Car.
2167. T. minuta *v.d. L.*—Nasturt. sylv., Ruta graveol., Dorycn. herbac., Ammi maj., Aegop. Podagr., Bupleur. rotund., Peuced. Oreos., Tordyl. apul., Dauc. Car.
2168. T. morio *F.*—Paliur. acul., Tordyl. apul., Orlaya grand.
2169. T. ruficornis *Klg.*—Oenan. aquat.

N. Sphegidae.

2170. Alyson fuscatus *Panz.*—Inula Hel.
2171. Ammophila affinis *K.* (cf. No. 2315).—Trif. arv., Eryng. camp., Tanac. vulg., Jas. mont.
2172. A. campestris *Ltr.* (cf. No. 2282).—Trif. mont. ♀ and ♂ F+I+, Rubus frutic., Knaut. arv., Thym. Serp.
2173. A. heydeni *Dahlb.*—Teucr. Pol.
2174. A. hirsuta *Scop.* (cf. Nos. 2177 and 2316).—Rubus frutic., Aegop. Podagr., Tussil. Farf.
2175. *A. lutaria F.* (=A. affinis *K.*).—Jas. mont.
2176. A. sabulosa *L.*, ♂ 4 mm.—Arab. hirsuta, Geran. pyren., Erod. cicut., Melilot.

altiss. F+I+, Vicia hirs. ↑, Rubus frutic., R. caes., Potent. Anser., P. rept., Spir. sorbif., S. salicif., S. ulmif., Epil. angust., Bryonia dioica F+I+, Eryng. marit., E. camp., Peuced. Cerv., Heracl. Sphond., Symphoric. racem. F+I+, Gal. Moll., Knaut. arv., Tussil. Farf., Aster conc., A. panicul. var. pubesc., A. sagittif., Galatel. hyssopif., Solidag. canad., S. Drummond., S. frag., S. glab., S. laterifl., Achill. Millef., A. Ptarm., Senec. nemor., S. Jacob., Cirs. arv., C. lanceol., Lappa min., Centaur. Jac., Hierac. umbell., Jas. mont., Asclep. syr. F+I+, Echium vulg., Mentha sylv., Thym. Serp., T. vulg.

2177. *A. viatica* (*L.*) *Dahlb.* (=A. hirsuta *Scop.*, cf. Nos. 2174 and 2316).—Campan. rot.
2178. A. sp.—Veron. mont.
2179. Astata boops *Schr.*—Paliur. acul., Dauc. Car.
2180. A. minor *Kohl.*—Paliur. acul., Ononis spin., Dauc. Car.
2181. Bembex integra *Panz.*—Thym. Serp.
2182. B. rostrata *L.* 7 mm.—Medic. sat. F+I+, Knaut. arv., Cirs. arv., Centaur. rhen., Jas. mont., Anchusa off., Echium vulg.
2183. *Cemonus unicolor F.* (=Pemphredon unicolor *F.*, cf. No. 2313).—Aneth. grav.
2184. Cerceris albofasciata *Rossi.*—Eryng. camp.
2185. C. arenaria *L.*—Res. lutea, Paliur. acul., Dorycn. herbac., Melilot. albus F+I+, Spir. sorbif., S. salicif., S. ulmif., Astrant. maj., Eryng. marit., Aegop. Podagr., Aneth. grav., Diplopap. amygd., Achill. Millef., A. Ptarm., Cirs. arv., Jas. mont., Call. vulg., Echium vulg., Thym. Serp.
2186. C. bupresticida *Duf.*—Paliur. acul., Dorycn. herbac.
2187. C. conigera *Dahlb.*—Paliur. acul., Teucr. Pol.
2188. C. emarginata *Pz.*—Res. lutea, Paliur. acul., Dorycn. herbac., Orlaya grand.
2189. C. ferreri *v.d. L.*—Dorycn. herbac.
2190. C. interrupta *Pz.*—Dauc. Car.
2191. C. labiata *F.* (cf. No. 2193).—Res. lutea, Dorycn. herbac., Epil. angust., Eryng. camp., Heracl. Sphond., Dauc. Car., Achill. Millef., A. Ptarm., Chrys. Leuc., Cirs. pal., Jas. mont., Veron. spic., Melamp. arv., Thym. Serp., Polygon. Fagop., Allium rot.
2192. C. leucozonica *Schett.*—Dorycn. herbac.
2193. *C. nasuta Ltr.* (=C. labiata *F.*, cf. No. 2191).—Heracl. Sphond., Achill. Millef., Cirs. arv.
2194. C. quadricincta *Vill.*—Paliur. acul.
2195. C. quadrifasciata *Pz.*—Res. lutea, Heracl. Sphond., Tordyl. apul., Orlaya grand., Thym. dalm.
2196. C. quadrimaculata *Duf.*—Paliur. acul., Dorycn. herbac.
2197. Cerceris quinquefasciata *Rossi.*—Paliur. acul., Rubus frutic., Dauc. Car., Toril. Anthr., Achill. Millef., Jas. mont., Veron. spic., Thym. Serp., Polygon. Fagop., Laur. nob., Antheric. ramos.
2198. C. rybiensis *L.* (cf. No. 2200).—Alyss. mont., Lepid. sat., Res. lutea, R. odor., Dorycn. herbac., Rubus frutic., Cirs. arv., Thym. Serp.
2199. C. specularis *Costa.*—Res. lutea, Paliur. acul., Dorycn. hirs., D. herbac.
2200. *C. variabilis Schr.* (=C. rybiensis *L.*, cf. No. 2198).—Sil. olit., Geran. sanguin., Astrant. maj., Eryng. camp., Aegop. Podagr., Dauc. Car., Solidag. glab., Achill. Millef., A. Ptarm., Anthem. arv., Tanac. corymb., Chrys. Leuc., Doronic. plantag., Cirs. arv., Card. acanth., Thrinc. hirt., Echinosp. Lapp., Veron. mont., Mentha sylv., Thym. Serp., Polygon. Bist., Antheric. ramos.
2201. Crabro alatus *Pz.*—Epil. angust., Heracl. Sphond., Dauc. Car., Achill. Millef., A. Ptarm., Anthem. arv., Cirs. arv., Jas. mont., Thym. Serp.
2202. C. albilabris *F.* (cf. No. 2273).—Aegop. Podagr., Aneth. grav., Heracl. Sphond., Dauc. Car., Leont. aut., Jas. mont., Thym. Serp.
2203. C. armatus *v.d. L.*—Dauc. Car.
2204. C. brevis *v.d. L.* (cf. No. 2254).—Res. lutea, Cucumis sat., Aegop. Podagr., Pimpin. Saxifr., Oenanth. aquat., Peuced. pal., Heracl. Sphond., Dauc. Car., Senec. Jacob., Thym. Serp., Euphorb. platyphyll., Epipact. pal. F+I+.
2205. *C. cephalotes F.* (=C. interrupte-fasciatus *Retz.*, cf. No. 2220).—Anthr. sylv., Chrys. Leuc.
2206. C. cetratus *Shuck.*—Arunc. sylv., Heracl. Sphond., Anthr. sylv.
2207. C. chrysostoma *Lep.* (cf. No. 2221).—Ruta graveol., Arunc. sylv., Aegop. Podagr., Heracl. Sphond., Anthr. sylv., Campan. Trach.
2208. C. clavipes *L.*—Ruta graveol., Aegop. Podagr.

2209. C. clypeatus *Schreb.* (cf. No. 2245).—Res. lutea, Paliur. acul., Petrosel. sat., Tordyl. apul., Dauc. Car., Centaur. Calcitr., C. solstit.
2210. C. cribrarius *L.*—Epil. angust., Aegop. Podagr., Levistic. off., Angel. sylv., Peuced. Cerv., Heracl. Sphond., Dauc. Car., Toril. Anthr., Anthr. sylv., Chaeroph. tem., Anthem. arv., Chrys. Leuc., Senec. Jacob., Cirs. arv., Butom. umb.
2211. C. denticrus *H.-Sch.*—Aneth. grav.
2212. C. distinguendus *A. Mor.*—Dauc. Car.
2213. C. dives (*Lep.*) *H.-Sch.*—Ruta graveol., Arunc. sylv., Pimpin. magn., Sium latif., Angel. sylv., Heracl. Sphond., Chaeroph. tem., Chrys. Leuc.
2214. C. elongatulus *v.d. L.*—Ruta graveol., Dauc. Car., Cusc. Epith.
2215. C. exiguus *v.d. L.*—Heracl. Sphond., Dauc. Car.
2216. C. fossorius *L.*—Conium macul.
2217. C. fuscitarsis *H.-Sch.*—Aegop. Podagr., Angel. sylv.
2218. C. gonager *Lep.*—Heracl. Sphond.
2219. C. guttatus *v.d. L.*—Ruta graveol., Heracl. Sphond.
2220. C. interrupte-fasciatus *Retz.* (cf. No. 2205).—Aegop. Podagr.
2221. *C. lapidarius Pz.* (=C. chrysostoma *Lep.*, cf. No. 2207).—Spir. sorbif., S. salicif., S. ulmif., Aegop. Podagr., Carum Car., Sium latif., Angel. sylv., Heracl. Sphond., Euphorb. Gerard.
2222. C. larvatus *Wesm.*—Ulmar. pentap., Heracl. Sphond.
2223. C. leucostoma *L.*—Arunc. sylv.
2224. C. lituratus *Pz.*—Aegop. Podagr., Pimpin. Saxifr., Aneth. grav., Heracl. Sphond.
2225. C. meridionalis *Costa.*—Paliur. acul., Tordyl. apul.
2226. C. nigritus *Lep.*—Anthrisc. sylv.
2227. C. palmarius *Schr.*—Dauc. Car., Leont. aut.
2228. C. panzeri *v.d. L.*—Thym. Serp.
2229. *C. patellatus Pz.* (=C. peltarius *Schreb.*, cf. No. 2230).—Heracl. Sphond., Jas. mont., Echium vulg.
2230. C. peltarius *Schreb.* (cf. No. 2229).—Rosa centif., Rubus frutic., Aegop. Podagr., Dauc. Car., Jas. mont., Echium vulg., Thym. Serp., Lysim. vulg.
2231. C. planifrons *Thoms.*—Aegop. Podagr., Anthrisc. sylv.
2232. C. podagricus *v.d. L.*—Aegop. Podagr., Aneth. grav., Heracl. Sphond.
2233. *C. pterotus F.* (=C. scutellatus *Schev.*, cf. No. 2237).—Jas. mont.
2234. C. pygmaeus *v.d. L.*—Dauc. Car.
2235. C. quadrimaculatus *Spin.*—Achill. Millef.
2236. C. rhaeticus *Aich. et Krchb.*—Liban. mont.
2237. C. scutellatus *Schev.* (cf. No. 2233).—Aegop. Podagr., Carum Car., Sium latif., Heracl. Sphond., Dauc. Car., Anthrisc. sylv., Knaut. arv., Senec. Jacob.
2238. C. serripes *Pz.*—Lavatera trim., Malope grandifl.
2239. C. sexcinctus *F.*—Aegop. Podagr., Angel. sylv., Aneth. grav., Pastin. sat., Heracl. Sphond., Dauc. Car., Anthr. sylv., Senec. Jacob., Picr. hierac.
2240. C. spinicollis *H.-Sch.*—Astrant. neglect., Aegop. Podagr., Heracl. Sphond.
2241. C. subterraneus *F.*—Rubus frutic., Conium macul., Aneth. grav., Heracl. Sphond., Chaeroph. hirs., Knaut. arv., Achill. Millef., A. Ptarm., Jas. mont.
2242. C. vagabundus *Pz.*—Aegop. Podagr., Carum Car., Heracl. Sphond., Dauc. Car., Anthrisc. sylv.
2243. C. vagus *L.*—Paliur. acul., Aegop. Podagr., Sium latif., Angel. sylv., Peuced. Cerv., Heracl. Sphond., Toril. Anthr., Anthr. sylv., Senec. Jacob., Cirs. arv.
2244. C. varius *Lep.*—Heracl. Sphond.
2245. *C. vexillatus Pz.* (=C. clypeatus *Schreb.*, cf. No. 2209).—Aethusa Cyn., Peuced. ruthen., Aneth. grav., Heracl. Sphond., Valer. offic., Diplopap. amygd., Solidag. glab., S. livida, Achill. Millef., A. Ptarm., Jas. mont.
2246. C. wesmaëli *v.d. L.*—Nasturt. sylv., Sperg. arv., Ulmar. pentap., Conium mac., Aegop. Podagr., Aneth. grav., Dauc. Car., Anthr. sylv., Senec. Jacob.
2247. C. sp.—Pastin. sat., Toril. Anthr., Tanac. vulg.
2248. *Dahlbomia atra F.* (=Mimesa atrata *F.* cf. No. 2276).—Heracl. Sphond.
2249. Didineis lunicornis *F.*—Dauc. Car.
2250. Dinetus guttatus *F.* (=*D. pictus F.*).—Aegop. Podagr., Heracl. Sphond., Achill. Millef., A. Ptarm., A. coronop., Tanac. vulg., T. corymb., Cirs. arv., Thym. Serp.
2251. Diodontus minutus *F.*—Geran. pusill., Tordyl. apul., Chaeroph. tem.

2252. D. tristis *v.d. L.*—Res. lutea, Tanac. vulg., Leont. aut.
2253. Dolichurus corniculus *Spin.*—Aegop. Podagr.
2254. *Entomognathus brevis v.d. L.* (=Crabro brevis *v.d. L.*, cf. No. 2204).—Conv. arv.
2255. Gorytes bicinctus *Rossi.*—Angel. sylv.
2256. G. bilunulatus *Costa.*—Heracl. Sphond.
2257. G. campestris *Müll.* (cf. No. 2260).—Rhus Cotinus, Parn. pal., Conium macul., Aepog. Podagr., Carum Car., Angel. sylv., Heracl. Sphond., Anthrisc. sylv., Butom. umb.
2258. G. consanguineus *Handl.*—Paliur. acul.
2259. G. fallax *Handl.*—Dauc. Car.
2260. *G. fargei Shuck.* (=G. campestris *Müll.*, cf. No. 2257).—Butom. umb.
2261. *G. laticinctus* (*Lep.*) *Shuck.*—Aegop. Podagr., Angel. sylv., Heracl. Sphond., Anthr. sylv.
2262. G. laevis *Latr.*—Heracl. Sphond., Dauc. Car.
2263. G. lunatus *Dhlb.*—Medic. lupul.
2264. G. mystaceus *L.*—Clemat. recta, Vicia sep., Crat. Oxyac., Bryon. dioica F+I+, Aegop. Podagr., Heracl. Sphond., Valer. off., Senec. Jacob., Ophrys. muscif.
2265. G. pleuripunctatus *Costa.*—Euon. japon., Paliur. acul., Foenic. vulg., Tordyl. apul.
2266. G. procrustes *Handl.*—Paliur. acul.
2267. G. quadrifasciatus *F.* (cf. No. 2271).—Aegop. Podagr., Sium latif., Angel. sylv., Heracl. Sphond., Dauc. Car., Anthr. sylv., Succ. prat., Senec. Jacob.
2268. G. quinquecinctus *F.*—Viscar. vulg., Paliur. acul., Dorycn. herbac., Angel. sylv., Heracl. Sphond., Dauc. Car., Cirs. arv.
2269. G. tumidus *Pz.*—Pimpin. Saxifr., Erythr. Cent.
2270. G. sp.—Heracl. Sphond.
2271. *Hoplisus quadrifasciatus F.* (=Gorytes quadrifasciatus *F.*, cf. No. 2267).—Heracl. Sphond.
2272. Larra anathema *Rossi.*—Paliur. acul.
2273. *Lindenius albilabris F.* (=Crabro albilabris *F.*, cf. No. 2202).—Achill. Millef., A. Ptarm., Cirs. arv., C. pal., Hypoch. radic., Thym. Serp., Allium sphaeroceph.
2274. Mellinus arvensis *L.*—Heracl. Sphond., Tanac. vulg., Senec. sylvat., S. Jacob., Leont. aut., Call. vulg., Eric. Tetr.
2275. M. sabulosus *F.*—Pimpin. magn., Pimpin. Saxifr., Silaus prat., Angel. sylv., Heracl. Sphond., Dauc. Car., Tanac. vulg., Jas. mont., Call. vulg., Thym. Serp.
2276. Mimesa atra *Pz.* (cf. No. 2248).—Angel. sylv., Heracl. Sphond.
2277. M. bicolor *Jur.*—Heracl. Sphond., Knaut. arv.
2278. M. dahlbomi *Wesm.*—Heracl. Sphond.
2279. M. equestris *F.*—Heracl. Sphond., Dauc. Car.
2280. M. unicolor *v.d. L.*—Heracl. Sphond.
2281. Miscophus bicolor *Sur.*—Aegop. Podagr.
2282. *Miscus campestris Ltr.* (=Ammophila campestris *Ltr.*, cf. No. 2172).—Jas. mont., Allium Cepa.
2283. *Notogonia pompiliformis Kohl.* (=Larra pompiliformis *Pz.*).—Chondrilla junc.
2284. Nysson dimidiatus *Jur.*—Dauc. Car.
2285. N. interruptus *F.*—Anthrisc. sylv.
2286. N. maculatus *F.*—Aegop. Podagr., Peuced. Cerv., Heracl. Sphond., Dauc. Car.
2287. N. scalaris *Ill.*—Paliur. acul.
2288. N. spinosus *Forst.*—Aegop. Podagr., Heracl. Sphond.
2289. *Oxybelus bellicosus Oliv.* (=O. lineatus *F.*, cf. No. 2293).—Toril. Anthr., Jas. mont.
2290. O. bellus *Dahlb.*—Lepid. sat., Ruta graveol., Potent. Anser., P. rept., P. frutic., Spir. sorbif., S. salicif., S. ulmif., Arunc. sylv., Aegop. Podagr., Achill. Millef., A. Ptarm.
2291. O. bipunctatus *Oliv.*—Aegop. Podagr., Oenan. aquat., Coniosel. tatar., Peuced. Ruthen., Dauc. Car., Diplopap. amygd., Solidag. glab., Jas. mont.
2292. O. furcatus *Lep.*—Melilot. altiss. F+I+, M. off. F+I+.
2293. O. lineatus *F.* (cf. No. 2289).—Aegop. Podagr., Aneth. grav., Senec. Jacob.
2294. O. mandibularis *Dahlb.*—Jas. mont.
2295. O. melancholicus *Chevr.*—Dorycn. herbac.

2296. O. mucronatus *F.*—Aneth. grav., Senec. Jacob., Cirs. arv., Sonchus arv., Hierac. umbell.
2297. O. nigripes *Oliv.*—Heracl. Sphond., Dauc. Car., Achill. Millef., A. Ptarm., Thym. Serp.
2298. O. pulchellus *Gerst.*—Aneth. grav.
2299. O. quattordecimnotatus *Jur.*—Gypsoph. panic., Galatella hyssopif., Diplopap. amygd., Achill. Millef.
2300. O. sericatus *Gerst.*—Geran. sanguin., Astrant. neglect., Senec. Jacob.
2301. O. trispinosus *F.*—Achill. Millef., A. Ptarm., Chrys. Leuc., Cirs. arv., Mentha sylv.
2302. O. uniglumis *L.*—Clemat. recta, Ranunc. acris, R. rep., R. bulb., Lepid. sat., Gypsoph. panic., Tilia ulmif., Erod. cicut., Rhus Cotinus, Rubus frutic., Fragaria vesca, Potent. Anser., P. procumb., P. frutic., Spir. sorbif., S. salicif., S. ulmif., Aruncus sylv., Sedum acre, Astrant. maj. var. interm., Aegop. Podagr., Sium latif., Aneth. grav., Heracl. Sphond., Dauc. Car., Toril. Anthr., Anthrisc. sylv., A. Ceref., Chaeroph. tem., Aster laevis, Galatel. hyssopif., Diplopap. amygd., Solidag. caes., S. glab., S. livida, Achill. Millef., A. Ptarm., Matric. Cham., Chrys. Leuc., Cirs. arv., Tarax. off., Sonchus arv., Jas. mont., Digit. purp., Thym. Serp., Polygon. Bist.
2303. O. sp.—Geran. sanguin.
2304. Passaloecus brevicornis *A. Mor.*—Aegop. Podagr., Cirs. arv.
2305. P. corniger *Shuck.*—Aegop. Podagr.
2306. *P. gracilis Curt.* (=? P. tenuis *Mor.*).—Veron. mont.
2307. P. insignis *Shuck.*—Spir. sorbif., S. salicif., S. ulmif.
2308. P. turionum *Dahlb.*—Ornithop. perpus. ♂ ? F±I+.
2309. Pemphredon lugens *Dahlb.*—Heracl. Sphond.
2310. P. lugubris *Ltr.*—Aethusa Cyn.
2311. P. rugifer *Dahlb.*—Anthr. sylv.
2312. P. shuckardi *A. Mor.*—Paliur. acul., Dauc. Car.
2313. P. unicolor *F.* (cf. No. 2183).—Sisymbr. off., Lepid. sat., L. graminifol., Paliur. acul., Ulmar. pentap., Bryonia dioica, Carum Car., Angel. sylv., Heracl. Sphond., Card. pycnoceph.
2314. Philanthus triangulum *F.*—Sil. Otit., Astrant. neglect., Eryng. camp., Aegop. Podagr., Angel. sylv., Heracl. Sphond., Knaut. arv., Achill. Millef., A. Ptarm. Echinops bannat., Cirs. arv., Jas. mont., Cusc. Epith.
2315. *Psammophila affinis K.* (=Ammophila affinis *K.*, cf. No. 2171).—Knaut. arv., Onopord. Acanth., Centaur. Cyan., Jas. mont., Asclep. syr. F+I+, Echium vulg., Salv. sylv.
2316. *P. viatia L.* (=Ammophila hirsuta *Scop.*, cf. No. 2174).—Peuced. Cerv., Knaut. arv., Senec. Jacob., Veron. spic.
2317. *Psen atratus Pz.* (=P. pallidipes *Pz.*, cf. No. 2319).—Spir. sorbif., S. salicif., S. ulmif., Aruncus sylv., Aegop. Podagr., Aneth. grav., Heracl. Sphond., Dauc. Car., Anthr. sylv.
2318. P. concolor *Dhlb.*—Aegop. Podagr., Anthr. sylv.
2319. P. pallidipes *Pz.* (cf. No. 2317).—Paliur. acul.
2320. Sceliphron destillatorium *Ill.*—Paliur. acul.
2321. S. omissum *Kohl.*—Paliur. acul.
2322. S. spirifex *L.*—Paliur. acul.
2323. Sphex maxillosus *F.*—Teucr. Pol.
2324. Tachysphex nitidus *Spin.*—Paliur. acul., Rubus caes., Peuced. Cerv., Chaeroph. tem.
2325. Tachysphex pectinipes *L.* (cf. No. 2329).—Peuced. Cerv., Heracl. Sphond., Dauc. Car.
2326. T. rufipes *Aich.*—Paliur. acul.
2327. Tachytes europaeus *Kohl.*—Dorycn. herbac.
2328. T. obsoletus *Rossi.*—Dorycn. herbac., Knaut. arv., Card. pycnoceph.
2329. *T. pectinipes L.* (=Tachysphex pectinipes *L.*, cf. No. 2325).—Aneth. grav., Jas. mont.
2330. Trypoxylon attenuatum *Sm.*—Aegop. Podagr., Heracl. Sphond.
2331. T. clavicerum *Lep.*—Aegop. Podagr., Aneth. grav.
2332. T. figulus *L.*—Ruta graveol., Sedum acre, Aegop. Podagr., Dauc. Car.

O. Tenthredinidae.

2333. Abia sericea *L.*—Aegop. Podagr., Carum Car., Pimpin. Saxifr., Angel. sylv., Heracl. Sphond., Anthrisc. sylv., Chrys. Leuc.

2334. Allantus albicornis *F.*—Heracl. Sphond., Anthr. sylv.
2335. A. arcuatus *Foerst.* (cf. Nos. 2340 and 2446).—Nasturt. amphib., Sedum Teleph., Aegop. Podagr., Pimpin. Saxifr., Sium latif., Liban. mont., Heracl. Sphond., Dauc. Car., Chaeroph. hirs.
2336. *A. bicinctus F.* (=A. temulus *Scop.*, cf. No. 2345).—Aegop. Podagr., Heracl. Sphond.
2337. A. fasciatus *Scop.*—Res. lutea, Tordyl. apul., Anthrisc. sylv.
2338. A. Koehleri *Klg.*—Anthrisc. sylv.
2339. A. marginellus *F.*—Rhus Cotinus, Heracl. Sphond., Dauc. Car., Anthrisc. sylv.
2340. *A. nothus Klg.* (=A. arcuatus *Foerst.*, cf. Nos. 2335 and 2446).—Silaus prat., Heracl. Sphond., Dauc. Car., Anthr. sylv., Sambuc. nigr., Achill. Millef., A. Ptarm., Anthem. arv., Chrys. Leuc., Cirs. arv.
2341. *A. omissus Foerst.* (A. viennensis *Pz.*, cf. No. 2349).—Pastin. sat., Heracl. Sphond., Dauc. Car.
2342. A. rossii *Pz.*—Chaeroph. hirs.
2343. A. schaefferi *Klg.*—Liban. mont.
2344. A. scrophulariae *L.*—Epil. angust., Heracl. Sphond., Achill. Millef., A. Ptarm., Chrys. Leuc., Verbasc. Lychn., Scrof. nod.
2345. A. temulus *Scop.* (cf. No. 2336).—Spir. sorbif., S. salicif., S. ulmif., Carum Car., Pimpin. Saxifr., Aethusa Cyn., Toril. Anthr., Anthr. sylv., Myrrhis odor., Euphorb. Cypar.
2346. *A. tricinctus Chr.* (=A. vespa *Retz.*, cf. No. 2347).—Heracl. Sphond., Scroph. orient.
2347. A. vespa *Retz.* (cf. No. 2346).—Carum Car., Liban. mont., Heracl. Sphond.
2348. A. viduus *Rossi.*—Paliur. acul., Peuced. Oreos., Tordyl. apul.
2349. A. viennensis *Pz.* (cf. No. 2341).—Peuced. Cerv.
2350. *Amasis laeta F.* (=Amasis crassicornis *Rossi*).—Ranunc. acris, R. rep., R. bulb., R. illyr., Cist. salviif., Geran. dissect., Melilotus altiss. F+I+, Potent. hirta, Tordyl. apul., Orlaya grand., Euphorb. Cypar.
2351. Amauronematus (=Nematus) fåhraei *Thoms.*—Salix alba, S. fragil.
2352. A. histrio *Lep.*—Salix cin., S. Capr., S. aurit., S. alba.
2353. A. viduatus *Zett.*—Salix alba, S. fragil., S. rep.
2354. A. vittatus *Lep.* (cf. No. 2420).—Anthr. sylv., Salix alba, S. fragil.
2355. Arge (=Hylotoma) cyaneocrocea *Foerst.* (cf. Nos. 2398 and 2401).—Sinap. arv., Paliur. acul., Tordyl. apul., Euphorb. heliosc., E. Cypar.
2356. A. enodis *L.* (cf. No. 2402).—Carum Car., Toril. Anthr.
2357. A. melanochroa *Gmel.* (cf. Nos. 2403 and 2404).—Tordyl. apul.
2358. A. rosae *L.* (cf. Nos. 2405 and 2406).—Toril. nod.
2359. A. ustulata *L.* (cf. No. 2408).—Toril. Anthr.
2360. Athalia annulata *F.*—Heracl. Sphond., Tordyl. apul., Anthr. sylv.
2361. A. glabricollis *Ths.*—Pimpin. Saxifr., Heracl. Sphond., Tordyl. apul., Anthrisc. sylv., Tanac. vulg.
2362. A. lugens *Klg.*—Anthrisc. sylv., Call. vulg.
2363. A. rosae *L.*—Thlaspi praec., Sium latif., Oenan. aquat., Angel. sylv., Heracl. Sphond., Dauc. Car., Anthrisc. sylv., Chaeroph. hirs., Myrrhis odor., Achill. Millef., A. Ptarm., Call. vulg., Scutell. albida, Ajug. pyram.
2364. A. rosae *L.* var. cordata *Lep.*—Paliur. acul., Tordyl. apul., Gal. Cruciat., Ajug. genev.
2365. A. rosae *L.* var. liberta *Klg.*—Caps. Bursa-past.
2366. A. spinarum *F.*—Caps. Bursa-past., Carum Car., Heracl. Sphond., Tordyl. apul., Anthrisc. sylv., Tanac. vulg., Ajug. genev., Polygon. Fagop.
2367. Cephus haemorrhoidalis *F.*—Melilot. altiss. F+I+.
2368. C. niger *Harr.*—Carum Car.
2369. C. nigrinus *Ths.*—Ranunc. repens, Hierac. Pilos.
2370. C. pallidipes *Klg.*—Ranunc. acris, R. rep., R. bulb., Stell. Holost., Tarax. off.
2371. C. pareyssei *Spin.*—Paliur. acul., Pimpin. peregr.
2372. C. pygmaeus *L.*—Ranunc. acris, R. rep., R. bulb., Sinap. arv., Raphan. Raph., Melilot. altiss. F+I+.
2373. C. variegatus *Stein.*—Cauc. dauc.
2374. C. sp.—Ranunc. acris, R. rep., R. bulb., Bunias orient., Saxifr. gran., Doronic. austriac., Tarax. off., Hierac. Pilos.
2375. Cladius pectinicornis *Fourcr.*—Geran. molle, Dauc. Car.
2376. Cyphona furcata *Vill.*—Dauc. Car.

2377. C. furcata *Vill.* var. melanocephala *Pz.*—Dorycn. herbac.
2378. Dolerus coruscans *Knw.*—Salix alba, S. fragil.
2379. *D. eglanteriae F.* (=D. pratensis *L.*, cf. No. 2386).—Salix rep.
2380. D. fissus *Htg.*—Carum Car., Toril. Anthr., Anthr. sylv., Salix alba, S. fragil.
2381. D. fumosus *Zadd.*—Salix alba, S. fragil.
2382. D. gonager *F.*—Prunus spin., Pyrus comm., Salix cin., S. Capr., S. aurit., S. alba, S. fragil.
2383. D. haematodes *Schr.*—Anthrisc. sylv., Salix alba, S. fragil.
2384. D. madidus *Klg.* (=*D. germanicus F.*).—Salix cin., S. Capr., S. aurit., S. alba, S. fragil., S. rep.
2385. D. picipes *Klg.*—Salix rep.
2386. D. pratensis *L.*—Aegop. Podagr., Carum Car., Heracl. Sphond., Tanac. vulg., Tarax. off., Salix cin., S. Capr., S. aurit.
2387. D. puncticollis *Thoms.*—Salix alba, S. fragil.
2388. *D. rugosus Konow.* (=D. rugosulus *D.T.*).—Salix alba, S. fragil.
2389. D. vestigialis *Klug.*—Arab. aren.
2390. Emphytes balteatus *Klg.*—Paliur. acul.
2391. E. cinctus *L.*—Tarax. off.
2392. Entodecta pumila *Klg.*—Heracl. Sphond.
2393. Eriocampa ovata *L.*—Aegop. Podagr.
2394. Hemichroa alni *L.*—Aegop. Podagr.
2395. *Hoplocampa ferruginea F.* (=H. flava *L.*).—Prunus spin.
2396. H. rutilicornis *Klg.*—Prunus spin.
2397. Hylotoma (Arge) berberidis *Schr.*—Peuced. Oreos., Ferul. montic.
2398. *H. caerulescens F.* (=H. cyaneocrocea *Forst.*, cf. Nos. 2355 and 2401).—Carum Car., Heracl. Sphond., Chaeroph. tem.
2399. H. caeruleopennis *Retz.* (cf. No. 2409).—Aegop. Podagr.
2400. H. ciliaris *L.* var. corrusca *Zadd.*—Aneth. grav.
2401. H. cyaneocrocea *Forst.* (cf. Nos. 2355 and 2398).—Conium macul.
2402. H. enodis *L.* (cf. No. 2356).—Carum Car., Heracl. Sphond., Chaeroph. hirs.
2403. *H. femoralis Klg.* (=H. melanochroa *Gmel.*, cf. Nos. 2357 and 2404).—Carum Car., Heracl. Sphond., Dauc. Car., Anthr. sylv.
2404. H. melanochroa *Gmel.* (cf. Nos. 2357 and 2403).—Aegop. Podagr.
2405. H. rosae *L.* (cf. Nos. 2358 and 2406).—Aegop. Podagr., Pimpin. Saxifr., Bupleur. falcat., Moloposp. Peloponnes.
2406. *H. rosarum Klg.* (=H. rosae *L.*, cf. Nos. 2358 and 2405).—Carum Car., Heracl. Sphond., Dauc. Car., Anthrisc. sylv.
2407. H. segmentaria *Pz.*—Conium macul., Chaeroph. hirs.
2408. H. ustulata *L.* (cf. No. 2359).—Aegop. Podagr., Heracl. Sphond., Dauc. Car., Euphorb. Cypar.
2409. *H. vulgaris Klg.* (=H. caeruleopennis *Retz.*, cf. No. 2399).—Heracl. Sphond.
2410. Macrophya albicincta *Schr.*—Liban. mont.
2411. M. diversipes *Schr.*—Paliur. acul., Liban. mont.
2412. M. militaris *Klg.*—Liban. mont.
2413. M. neglecta *Klg.*—Paliur. acul., Anthrisc. sylv.
2414. M. quadrimaculata *F.*—Carum Car., Toril. Anthr.
2415. M. ribis *Schr.*—Euphorb. Cypar.
2416. M. rufipes *L.*—Heracl. Sphond.
2417. M. rustica *L.*—Paliur. acul., Rubus Id., Heracl. Sphond., Tordyl. apul., Anthr. sylv.
2418. Megalodontes cephalotes *F.* (cf. No. 2435).—Geran. sanguin.
2419. *Nematus capreae L.* (=Pachynematus capreae *L.*, cf. No. 2422).—Pyrus comm.
2420. *N. vittatus L.* (=Amauronematus vittatus *L.*, cf. No. 2354).—Conium macul.
2421. N. spec.—Carum Car.
2422. Pachynematus (Nematus) capreae *Pz.* (cf. No. 2419).—Salix rep.
2423. Pachyprotasis rapae *L.*—Carum Car., Toril. Anthr., Anthr. sylv., Gal. verum, Tarax. off.
2424. Pamphilius hortorum *Klg.*—Anthr. nit.
2425. P. sylvaticus *L.*—Crataeg. Oxyac.
2426. Poecilostoma luteolum *Klg.*—Dauc. Car., Anthrisc. sylv.
2427. Pteronus (Nematus) brevivalvis *Thoms.*—Salix alba, S. fragil.
2428. P. hortensis *Htg.*—Ribes rubrum.
2429. P. monticola *Ths.*—Anthrisc. sylv.

2430. P. myosotidis *F.*—Anthrisc. sylv.
2431. P. ribesii *Scop.*—Ribes Gross.
2432. Rhogogastera viridis *L.*—Ang. sylv., Anthrisc. sylv., Myrrhis odor.
2433. Selandria cinereipes *Klg.*—Heracl. Sphond.
2434. S. serva *F.*—Aegop. Podagr., Carum Car., Pimpin. Saxifr., Sium latif., Angel. sylv., Dauc. Car., Anthrisc. sylv.
2435. *Tarpa cephalotes F.* (=Megalodontes cephalotes *F.*, cf. No. 2418).—Gal. bor., Inula hir., Anthem. tinct., Tanac. corymb., Senec. Jacob., Crep. bien.
2436. *T. spissicornis Klg.* (=Megalodontes Klugii *Leach*).—Tarax. off.
2437. Tenthredo atra *L.*—Aegop. Podagr., Anthrisc. sylv.
2438. *T. bifasciata Klg.* (=Allantus rossii *Panz.*, cf. No. 2342).—Aegop. Podagr., Carum Car., Heracl. Sphond.
2439. T. coryli *Pz.*—Dauc. Car.
2440. T. dispar *Klg.*—Liban. mont.
2441. T. fagi *Pz.*—Liban. mont.
2442. T. flava *Poda* (cf. No. 2443).—Aegop. Podagr., Liban. mont.
2443. *T. flavicornis F.* (=T. flava *Poda*, cf. No. 2442).—Aegop. Podagr., Anthrisc. sylv., Myrrhis odor.
2444. *T. ignobilis Klg.* (=? var. of T. atra *L.* (*teste* Konow.)).—Euphorb. Cypar.
2445. T. livida *L.*—Aegop. Podagr., Anthrisc. sylv.
2446. *T. notha Kl.* (=Allantus arcuatus *Foerst.*, cf. Nos. 2335 and 2340).—Toril. Anthr.
2447. T. sp.—Hyper. perfor., Melilot. altiss. F±I±, Parn. pal., Conium mac., Aegop. Podagr., Oenan. aquat., Selinum carvif., Angel. sylv., Peuced. Oreos., Aneth. grav., Heracl. Sphond., Anthrisc. sylv., Chaeroph. hirs., C. Villars., Achill. Millef., A. Ptarm., Chrys. Leuc., Leont. hast., Polygon. Bist.
2448. Tenthredopsis austriaca *Knw.*—Paliur. acul.
2449. T. dorsalis *Lep.*—Paliur. acul.
2450. T. gibberosa *Knw.*—Anthrisc. sylv.
2451. T. raddatzi *Konow.* var. vittata *Knw.*—Paliur. acul.
2452. T. scutellaris *F.*—Anthrisc. nit.
2453. T. thomsoni *Knw.* var. femoralis *Steph.*—Paliur. acul.
2454. T. thomsoni *Knw.* var. nigripes *Knw.*—Paliur. acul.
2455. Tomostethus fuliginosus *Klg.*—Salix alba, S. fragil.
2456. Trichiosoma betuleti *Klg.*—Syringa vulg.

P. Vespidae.

2457. *Ancistrocerus parietum L.* (=Odynerus parietum *L.*, cf. No. 2496).—Levist. off., Orlaya grand., Dipsac. sylv., Allium Cepa.
2458. *A. renimacula Lep.* (=Odynerus parietum *L.* var. renimacula *Lep.*, cf. No. 2497).—Thym. vulg.
2459. Celonites abbreviatus *Vill.*—Calamintha alpina, Teucr. mont.
2460. Discoelius zonalis *Pz.*—Heracl. Sphond.
2461. *Epipona spiricornis Spin.* (=Odynerus spiricornis *Spin.*, cf. No. 2506).—Allium Cepa.
2462. Eumenes arbustorum *Pz.* var. dimidiata *Brullé.*—Heracl. Sphond.
2463. E. coarctata *L.*—Melilot. albus F+I+, Aegopod. Podagr., Foenic. vulg., Orlaya grand., Diplopap. amygd., Solidag. Drumm., Rudb. specios., Achill. Millef., A. filipend., A. grand., Centaur. Scab.
2464. E. mediterranea *Krchb.*—Paliur. acul., Hedera Hel., Lonic. etrusca.
2465. E. pomiformis *F.*—Res. lutea, Ruta graveol., Euon. japon., Rhamn. Frang., Paliur. acul., Rhus Cotinus, Dorycn. herbac., Bryon. dioica ♂ F+I+, Sedum album, Eryng. ameth., Foenic. vulg., Aneth. grav., Orlaya grand., Symphoric. racem. F+I+, Diplopap. amygd., Cirs. arv., Mentha aquat., Euphorb. Cypar., Allium Cepa.
2466. E. unguiculata *Vill.*—Foenic. vulg., Orlaya grand., Allium sphaeroceph., A. Cepa.
2467. *Hoplopus levipes Shuck.* (=Odynerus levipes *Shuck.*, cf. No. 2490).—Scroph. nod.
2468. *Leionotus bidentatus Lep.* (=Odynerus bidentatus *Lep.*, cf. No. 2479).—Allium Cepa.
2469. *L. chevrieranus Sauss.* (=Odynerus chevrieranus *Sauss.*, cf. No. 2471).—Orlaya grand.

2470. *L. dantici Rossi* (=Odynerus dantici *Rossi*, cf. No. 2484).—Orlaya grand., Allium Cepa.
2471. *L. dufourianus Sauss.* (=Odynerus chevrieranus *Sauss.*, cf. No. 2469).—Chaeroph. tem.
2472. *L. minutus F.* (=Odynerus minutus *F.*, cf. No. 2492).—Angel. sylv.
2473. *L. parvulus Lep.* (=Odynerus parvulus *Lep.*, cf. No. 2498).—Orlaya grand.
2474. *L. rossii Lep.* (=Odynerus rossii *Lep.*, cf. No. 2503).—Viburn. Lant.
2475. *L. simplex Fabr.* (=Odynerus quadrifasciatus *F.*, cf. Nos. 2494 and 2501).—Orlaya grand., Anthrisc. sylv.
2476. *L. tarsatus Sauss.* (=Odynerus tarsatus *Sauss.*, cf. No. 2507).—Orlaya grand.
2477. Odynerus alpestris *Sauss.*—Paliur. acul.
2478. O. antilope *Pz.*—Rubus Id.
2479. O. bidentatus *Lep.* (cf. No. 2468).—Paliur. acul., Sedum album, Foenic. vulg.
2480. O. bifasciatus *L.*—Foenic. vulg., Heracl. Sphond.
2481. O. callosus *Ths.*—Ribes Gross., Tarax. off., Salix alba, S. frag.
2482. O. claripennis *Thoms.*—Heracl. Sphond., Linar. vulg.
2483. O. crassicornis *Pz.*—Heracl. Sphond.
2484. O. dantici *Rossi* (cf. No. 2470).—Paliur. acul., Eryng. ameth.
2485. O. debilitatus *Sauss.*—Angel. sylv., Aneth. grav.
2486. *O. elegans Wsm.* (=O. gracilis *Brullé*, cf. No. 2489).—Aegop. Podagr., Anthrisc. sylv.
2487. O. floricola *Sauss.*—Euon. japon., Paliur. acul.
2488. O. gazella *Pz.*—Heracl. Sphond.
2489. O. gracilis *Brullé* (cf. No. 2486).—Aegopod. Podagr.
2490. O. levipes *Shuck.* (cf. No. 2467).—Paliur. acul.
2491. O. melanocephalus *L.*—Aquileg. vulg., Malva sylv., Crat. Oxyac.
2492. O. minutus *Fabr.* (cf. No. 2472).—Heracl. Sphond., Melamp. arv.
2493. O. modestus *Sauss.*—Euon. japon., Paliur. acul., Foenic. vulg., Teucr. Pol.
2494. *O. nigripes H.-Sch.* (=O. quadrifasciatus *F.*, cf. Nos. 2478 and 2501).—Syring. chin., Euphorb. virg.
2495. O. oviventris *Wesm.*—Viola tric. versic. F±I+, Spir. sorbif., Heracl., Sphond,. Anthrisc. sylv., Knaut. arv.
2496. O. parietum *L.* (cf. 2457).—Clemat. Vitalba, C. recta, Res. lutea, Viola tric. vulg. F±I+, V. tric. alp., Gypsoph. panic., Ruta graveol., Paliur. acul., Medic. sylvestr., Rubus Id., Sanguis. minor, Crat. Oxyac., Sorbus Auc., Bryon. dioica ♀ F+I+, Bergenia subcil., Astrant. maj., Eryng. camp., Conium mac., Petrosel. sat., Oenan. aquat., Liban. mont., Silaus prat., Angel. sylv., Aneth. grav., Pastin. sat., Heracl. Sphond., Siler trilob., Dauc. Car., Toril. Anthr., Anthrisc. sylv., Symphoric. racem. F+I+, Knaut. arv., Aster squarrul., Diplopap. amygd., Solidag. Drummond, S. glab., Achill. Millef., A. Ptarm., Tanac. vulg., T. macroph., Cirs. arv., Rhapont. pulch., Centaur. Fisch., Tragop. floccos., Tarax. off., Borago off., Echium vulg., Linar. vulg., Lysim. vulg., Salix cin., S. Capr., S. aurit.
2497. O. parietum *L.* renimacula *Lep.* (cf. No. 2458).—Melilot. albus F+I+, Gaura bien., Pastin. sat., Symphoric. racem. F+I+, Diplopap. amygd., Mentha aquat.
2498. O. parvulus *Lep.* (cf. No. 2473).—Foenic. vulg., Pastin. sat.
2499. O. pictus *Curt.*—Matric. inod., Senec. Jacob.
2500. *O. quadratus Pz.* (Sp. incertae sedis).—Lathyr. latif., Saxifr. umbrosa, Archang. off. (?), Scroph. aquat., S. orient., Digit. purp.
2501. O. quadrifasciatus *F.* (cf. Nos. 2475 and 2494).—Gypsoph. panic., Vicia Cracca F±I±.
2502. *O. quinquefasciatus F.* (=O. spinipes *L.*, cf. No. 2506).—Aegop. Podagr.
2503. O. rossii *Lep.* (cf. No. 2474).—Pastin. sat.
2504. O. simplex *Fabr.*—Astrant. maj.
2505. O. sinuatus *F.*—Rhus Cotinus, Spir. salicif., Arunc. sylv., Foenic. vulg., Aegop. Podagr., Angel. sylv., Heracl. Sphond., Dauc. Car., Achill. Millef., A. Ptarm.
2506. O. spinipes *L.* (cf. No. 2502).—Ranunc. acris, R. rep., R. bulb., Geran. pyren., Rhus Cotinus, Spir. sorbif., S. salicif., S. ulmif., Pimpin. Saxifr., Anthrisc. sylv., Cornus sang., Achill. Millef., A. Ptarm.
2507. O. spiricornis *Spin.* (cf. No. 2461).—Heracl. Sphond.
2508. O. tarsatus *Sauss.* (cf. No. 2476).—Geran. rotundif.
2509. O. trifasciatus *F.* (a good sp., *teste* Morawitz).—Genista tinct. F±I±, Silaus

prat., Peuced. Oreos., Heracl. Sphond., Diplopap. amygd., Cirs. arv., Astrant. maj., Ribes rupr.

2510. O. xanthomelas *H.-Sch.*—Lotus corn.
2511. O. spec.—Symphoric. racem. F±I+, Syring. vulg., Origan. vulg.
2512. Polistes biglumis *L.* (cf. No. 2513).—Coton. integ. F+I+, Eryng. camp., Bupleur. falcat., Peuced. Cerv., Pastin. sat.
2513. *P. diadema Ltr.* (=P. biglumis *L.*, cf. No. 2512).—Symphoric. racem. F+I+, Echinops sphaeroc., Cirs. arv., C. lanceol., Asclep. syr. F+I+, Lycop. europ.
2514. P. gallica *L.*—Res. lutea, Impat. Balsam., Ruta graveol., Euon. japon., E. varieg., Rhamnus Frang., Paliur. acul., Dorycn. herbac., Melilot. altiss. F+I+, Lathyr. prat., Prunus spin., P. Mahaleb, Eryng. camp., E. ameth., Petrosel. sat., Aegopod. Podagr., Bupleur. falcat., Foenic. vulg., Liban. mont., Peuced. Cerv., Aneth. grav., Pastin. sat., Heracl. Sphond., Tordyl. apul., Orlaya grand., Anthr. sylv., Hedera Hel., Symphoric. racem. F+I+, Echinops sphaeroc., Cirs. lanceol., Centaur. Jac., Eric. arb., Asclep. syr. F+I+, Cusc. Epith., Verbasc. Thaps., Lycop. europ., Satureia mont., Thym. dalm., Rosmar. off., Teucr. Pol., Laur. nob., Euphorb. Cypar., Sabal. Adans.
2515. Pterocheilus phaleratus *Pz.*—Pimpin. Saxifr., Achill. Millef., A. Ptarm.
2516. Vespa austriaca *Pz.*—Aegop. Podagr., Heracl. Sphond., Epipact. latif. F+I+.
2517. V. crabro *L.*—Tilia ulmif., Euon. japon., Sedum album, Aster Lindl., A. panicul. var. pubesc., Diplopap. amygd., Solidag. fragr., Salix alba, S. fragil.
2518. V. germanica *F.*—Anem. jap. var. purpurea, Euon. japon., Crat. Oxyac., Pyrus Malus, Ribes Gross., Foenic. vulg., Angel. sylv., Aneth. grav., Heracl. Sphond., Hedera Hel., Aster Amel., A. prenanthoid., Solidag. fragr., S. glab., S. laterifl., S. lithosp., S. Ridel., S. ulmif., Bolton. glastif., Syring. vulg., Scroph. nod., Lam. mac. F±I±, Salix cin., S. Capr., S. aurit.
2519. *V. holsatica F.* (=V. sylvestris *Scop.*, cf. No. 2524).—Berb. vulg., Astrant. maj., Foenic. vulg., Angel. sylv., Call. vulg., Scroph. nod.
2520. V. media *Retz.*—Impat. Noli-tang. F+I+, Symphoric. racem. F+I+.
2521. V. norvegica *F.*—Rubus Id., Eryng. ameth., Eupat. can.
2522. V. rufa *L.*—Berb. vulg., Vicia sat., Angel. sylv., Heracl. Sphond., Anthrisc. sylv., Symphoric. racem. F+I+, Anthem. tinct., Senec. nemor., Scroph. nod., Melamp. sylv., Epipact. pal. F+I+, Allium Cepa.
2523. Vespa saxonica *F.*—Ranunc. acris, R. rep., R. bulb., Euon. japon., Symphoric. racem. F+I+.
2524. V. sylvestris *Scop.* (cf. No. 2519).—Rhamn. Frang., Vicia sat., Rubus Id., Crat. Oxyac., Ribes Gross., Heracl. Sphond., Toril. Anthr., Anthr. sylv., Symphor. racem. F+I+, Picr. hierac., Solan. Dulc., Scroph. aquat., S. umbr., S. alpestr., Epipact. pal. F+I+.
2525. V. vulgaris *L.*—Medic. sat., Sicyos. angul., Ribes Gross., Heracl. Sphond., Hedera Hel., Symphor. racem. F+I+, Helichrys. bract., Cirs. arv., Call. vulg., Scroph. nod., Epipact. pal. F+I+.
2526. V. sp.—Amygd. comm., Sanic. europ., Conium macul., Cicuta vir., Aegop. Podagr., Lonic. alpig., Scroph. aquat., Salix retusa.

V. LEPIDOPTERA

A. Bombycidae.

2527. Callimorpha dominula *L.*, 9–10 mm.—Eupator. cannabin.
2528. C. hera *L.*—Eupator. cannabin., Origan. vulg.
2529. Dasychira pudibunda *L.*—Lonicera Caprifol. F±I±.
2530. Euchelia jacobaeae *L.*—Arab. hirsuta.
2531. Gnophria quadra *L.*—Dianth. delt., Trif. prat. F±I±.
2532. Nemeophila plantaginis *L.*—Crepis aurea.
2533. Porthesia similis *Fuessl.*—Lotus corn. F±I±.
2534. Pygaera anastomosis *L.*—Salix triandra.

B. Geometridae.

2535. Acidalia humiliata *Hufn.*—Ononis spin. F±I±.
2536. A. virgularia *Hbn.*—Lavand. vera.
2537. Cidaria hydrata *Fr.*—Sil. nut.

2538. Fidonia famula *Esp.*—Saroth. scop. F±I±.
2539. Halia brunneata *Thnbg.*—Vacc. Myrt.
2540. H. wauaria *L.*—Lavand. vera.
2541. Jodis lactearia *L.*—Hesper. trist.
2542. Minoa murinata *Scop.*, 4 mm.—Asperula cynanch.
2543. Odezia atrata *L.* (cf. No. 2544).—Chaerophyll. Villarsii.
2544. *O. chaerophyllata L.* (=O. atrata *L.*, cf. No. 2543), 7 mm.—Polyg. vulg., Astrag. glycyph.
2545. Ortholitha cervinata *S.V.*—Althaea rosea.
2546. Timandra amata *L.*—Lythr. Sal. F+I+, Scroph. aquat.

C. Noctuidae.

2547. Acronycta aceris *L.*—Centaur. rhen.
2548. Aedia funesta *Esp.*—Ligustr. vulg.
2549. Agrotis castanea *Esp.*—Call. vulg.
2550. A. conflua *Tr.*—Polygon. Bistorta.
2551. A. exclamationis *L.*—Lavand. off.
2552. A. latens *Hbn.*—Lavand. vera.
2553. A. ocellina *Hbn.*, 9–10 mm.—Semperviv. mont., Cirs. spinosis., Crep. aurea, Phyteuma orbic., Polygon. Bistorta.
2554. A. pronuba *L.*—Dianth. chin., Medic. sat. F+I+, Erythr. Cent.
2555. A. vestigialis *Rott.*—Eryng. camp., Thym. Serp.
2556. A. ypsilon *Rott.*—Salv. prat. F±I±.
2557. A. sp.—Symphoricarp. racem. F+I+.
2558. Anarta melanopa *Thnb.*—Silene acaul.
2559. A. myrtilli *L.*—Chrysanth. Leucanth.
2560. A. nigrita *Boisd.*—Silene acaul.
2561. Brotolomia meticulosa *L.*—Dianth. chin.
2562. Charaeas graminis *L.*, 7–8 mm.—Succ. prat., Senec. Jacob.
2563. Chariclea delphinii *L.*—Cent. Cyanus.
2564. C. umbra *Hfn.*—Phaseolus vulg. F±I±.
2565. Cucullia chamomillae *Schiff.*—Sil. nut.
2566. C. umbratica *L.*, 18–22 mm.—Viola corn., Lonic. Caprifol. F+I+.
2567. Dianthoecia albimacula *Bkh.*—Sil. nut.
2568. D. capsincola *Hbn.* 23–25 mm.—Lonicera Caprifol. F+I+.
2569. D. compta *F.*—Dianth. Carthus.
2570. D. filigrana *Esp.*—Melandr. rubr.
2571. D. nana (*Hufn.*) *Rott.*—Hesper. trist., Sil. infl., Coron. Fl.-cuc., Melandr. alb., M. rubr.
2572. Euclidia glyphica *L.*, 8–12 mm.—Ranunc. acris, R. rep., R. bulbos., Arab. aren., Sinap. arv., Coron. Fl.-cuc., Cerast. arv., Medic. falc., Lotus corn. F±I+, Onobr. viciif., Lythr. Sal. F+I+, Knaut. arv., Cirs. olerac., Rhinanth. major.
2573. E. mi *L.*—Valerian. olitor., Hierac. Pilos.
2574. Gnophos furvata *F.*—Scrophul. aquat.
2575. Hadena didyma *Esp.*—Tanacet. vulg.
2576. H. fasciuncula *Haw.*—Medic. lupul.
2577. H. monoglypha *Hufn.*—Haben. bif. F+I+.
2578. H. sp.—Hesper. trist.
2579. Hydroecia nictitans *Bkh.*—Aster Trip., Achill. Millef., Armer. elong.
2580. H. nictitans *Bkh.* var. erythrostigma *Haw.*—Cirs. arv.
2581. Hypena proboscidalis *Fr.*—Asclep. syr.
2582. Luperina haworthii *Curt.*—Succ. prat.
2583. Mamestra dentina *Esp.*—Haben. chlor. F+I+.
2584. M. serena (*S.V.*) *F.*—Knaut. arv.
2585. M. sp.—Symphoric. racem. F+I+.
2586. Mithymna imbecilla *F.*—Polygon. Bist.
2587. Phasiane clathrata *L.*—Medic. sat. F+I+.
2588. Plusia chrysitis *L.*—Lycium barb.
2589. P. festucae *L.*—Echium vulg.
2590. P. gamma *L.*, 15–16 mm.—Hesper. trist., Cak. marit., Dianth. Carthus., D. chin., Sil. infl., S. Otit., Melandr. alb., Linum usitat., Medic. sat. F+I+, Trif. rep. F±I± ? F±I+, T. prat. F+I+, Lotus corn. ? F±I+, Astrag. depr., Onobr. viciif., Lathyr. sylv. F±I+, Parnass. pal., Toril. Anthr.,

Lonic. Periclym. F+I+, L. Caprifol., Gall. Moll., Knaut. arv., Succ. prat., Chrysoc. Linosyr., Senec. Jacob., Cirs. arv., C. lanceol., C. pal., Carduus acanthoid., Lappa min., Centaur. Jac., C. Cyanus, C. Scab., C. rhen., Thrinc. hirta, Leont. aut., Jas. mont., Call. vulg., Erica Tetr., Asclep. syr., Araujia alb., Erythr. Cent., Phlox panicul., Conv. arv., Borago off., Anchusa off., Echium vulg., Melamp. nemor., Salv. prat. F±I±, Lavand. vera, Monarda didyma, Stach. pal., Ball. nigra F+I+, Ajug. rept. F±I+, Armer. elong., Polygon. Pers., Haben. bif. F+I+.

2591. P. triplasia *L.*—Coreops. lanceol., Lavand. vera.
2592. P. sp.—Cytis. Lab. F±I+, Symphoricarp. racem. F+I+, Lonic. Periclym. F+I+.
2593. Scoliopteryx libatrix *L.*—Rubus Id.
2594. Toxocampa craccae *F.*—Vicia sep.

D. Pyralidae.

2595. Botys purpuralis *L.*—Succ. prat., Tanacet. vulg., Achill. Millef., A. Ptarm., Polygon. Bist.
2596. B. purpuralis *L.* var. ostrinalis *Hbn.*—Origan. vulg.
2597. B. sambucalis *Schiff.*—Sambuc. nigra.
2598. Crambus alpinellus *Hbn.*—Artem. camp.
2599. C. furcatellus *Zett.*—Mentha aquat.
2600. C. pratellus *L.*—Medic. lupul.
2601. C. sp.—Senec. Jacob., Leont. aut., Centaur. nigra.
2602. Ephestia elutella *Hbn.*—Verbasc. nigr.
2603. Eurrhypara urticata *L.*—Lavand. vera.
2604. Eurycreon turbidalis *Tr.*—Artemis. camp.
2605. E. verticalis *L.*—Carduus crisp.
2606. Orobena limbata *L.*—Asperula tinct.
2607. Pempelia ornatella *S.V.*—Thym. Serp.
2608. Pionea forficalis *L.*—Hesper. trist.
2609. Scoparia ambigualis *Tr.*—Ligustr. vulg.
2610. Threnodes pollinalis *Schiff.*—Saroth. Scop. F±I±, Genista pilosa F±I±, Cytis. sagitt.
2611. Trifurcula immundella *Zell.*—Saroth. scop. F±I±.
2612. Pyralidae *sp.* ?—Lam. mac.

E. Rhopalocera.

2613. Anthocaris belia *Cr.* var. simplonia *Freyer.*—Sinap. Cheiranth.
2614. A. cardamines *L.*, 12 mm.—Cardam. prat., Viola sylv., V. can., F+I+, Ligustr. vulg., Pulmon. off., Hotton. pal. F+I+.
2615. Aporia crataegi *L.* (cf. No. 2691).—Echium vulg.
2616. Argynnis adippe *L.*, 13–14 mm.—Trif. prat. F+I+, Cirs. arv., Leont. aut., Thym. Serp.
2617. A. aglaia *L.*, ♂ 15–16 mm., ♀ 17–18 mm.—Peuced. pal., Knaut. arv., Scab. lucida, Achill. Millef., Cirs. arv., Carduus acanthoid., C. nutans, Centaur. nigra, C. rhen., Leont. aut., Thym. Serp., Armer. elong.
2618. A. chariclea *Schneid.*—Ledum pal.
2619. A. dia *L.*—Convolv. arv.
2620. A. ino *Rott. Esp.*, 9–12 mm.—Knaut. arv.
2621. A. latonia *L.*, 11–12 mm.—Knaut. arv., Scab. Columb., Centaur. Scabiosa, C. salicifol., Picris hieracioid, Crep. bienn., Hierac. umbell., Jas. mont., Conv. arv.
2622. A. niobe *L.*, 13–16 mm.—Knaut. arv., Cirs. arv., Thym. Serp.
2623. A. pales *S.V.*, 9–10 mm.—Visc. alb., Oxytrop. camp., Leont. hast., Haben. angustif.
2624. A. pandora *S.V.*—Dianth. delt., Ulmar. pentap., Peuced. pal., Achill. Millef., Thym. Serp.
2625. A. paphia *L.*, 12–14 mm.—Hyper. perfor., Lupin. lut. F±I+, L. angustif. F±I+, Rubus frutic., Angel. sylv., Peuced. pal., Knaut. arv., Eupator. cannabin., Cirs. pal., Carduus nut., Leont. aut., Jas. mont., Solan. Dulc. Origan. vulg., Ball. nigr. F+I+.
2626. A. paphia *L.* var. valesina *Esp.*—Rubus frutic., Aegopod. Podagr., Libanot. mont., Knaut. arv.
2627. A. selene *S.V.*, 9–10 mm.—Crepis aurea.

2628. A. sp.—Aster Novae-Angl., Centaur. nigra, Rhinanth. minor., Rumex spec., Lil. bulbif.
2629. Carterocephalus palaemon *Pall.*—Rubus frutic.
2630. Coenonympha arcania *L.*—Dianth. Carthus., Trif. alp. F±I±, Lotus corn. F±I±, Vicia pisiform. F±I+, Rubus frutic., Asperula cynanch., Achill. Millef., A. Ptarm., Ligustr. vulg., Thym. Serp., Antheric. ramos.
2631. C. pamphilus *L.*, 6½–7 mm.—Ranunc. Flamm., R. acris, R. rep., R. bulb., Raphan. Raphan., Sil. Otit., Trif. rep. (F+I+), T. prat. F+I+, T. alp., F±I±, T. med., T. arv. F+I+, Lotus corn. F±I+, Vicia hirs. F±I+, Lens escul., Scler. perenn., Orlaya grandifl., Succ. prat., Bellis per., Inula hirta, Centaur. Jacea, Hypoch. radic., Achill. Millef., A. Ptarm., Jas. mont., Call. vulg., Erica Tetr., Ligustr. vulg., Myosot. interm., Mentha sylv., Thym. Serp., Ajug. rept. F±I+, Armer. elong., Polygon. amphib.
2632. Colias boothii *Curt.* (=*C. hecla Lef.*, cf. No. 2634).—Tarax. offic., Phyllodoce taxif.
2633. C. edusa *F.*, 14–16 mm.—Medic. sat. F+I+.
2634. Colias hecla *Lef.* (cf. No. 2632).—Pedicul. tuber.
2635. Colias hyale *L.*, 12–13 mm.—Dianth. Carthus., Medic. sat. F+I+, M. falc., Trif. rep. F±I±, Knaut. arv., Centaur. Jacea, Cichor. Intyb., Leont. aut., Serrat. tinct., Echium vulg., Ball. nigra F+I+.
2636. Colias phicomene *Esp.*, 13–14 mm.—Leont. hastil.
2637. *Colias rhamni L.* (=Rhodocera rhamni *L.*, cf. No. 2702).—Lathyr. latif. var. ensif., Bergenia subcil., Scab. Columb., Echinops exalt.
2638. Epinephele hyperanthus *L.* (cf. Nos. 2651 and 2703).—Trif. rub., T. agrar. F+I+, Valer. off., Senec. Jacob., Cirs. arv., C. pal., Hierac. vulg., Mentha sylv., Origan. vulg., Clinopod. vulg., Stachys Beton F±I+, Colchic. aut.
2639. E. hyperanthus *L.* var. arete *Müll.*—Thym. Serp.
2640. E. janira *L.*, 10 mm. (cf. No. 2652).—Cak. marit., Dianth. delt., Sil. infl., S. Otit., Hyper. perfor., Medic. falc., Trif. rep. (F+I+), T. prat. F+I+, T. alp. F±I±, T. procumb. F+I+, Anthyllis Vuln. F±I+, Lotus corn. F±I+, Rubus frutic., R. caes., Comarum pal., Sedum acre, S. refl., Aneth. graveol., Toril. Anthr., Gal. verum, Knaut. arv., Succ. prat., Aster Amellus var. Bessarabicus, Solid. Virgaur., S. laterifl., Achill. Millef., A. Ptarm., Anthemis tinctor., Chrysanth. Leucanth., Senec. Jacob., Cirs. arv., C. lanceolat., C. pal., Carduus acanthoid., C. nutans, Centaur. Jacea, C. nigra, C. Scab., C. conglom., Leont. aut., Picris hieracioid., Hypoch. rad., Crep. bien., Hierac. vulgat., H. umbellat., Jas. mont., J. perenn., Erica Tetr., E. cin., Ligustr. vulg., Conv. arv., Echium vulg., Melamp. nemor., Lavand. vera, Mentha arv., Origan. vulg., Thym. Serp., Nepeta nuda, Armer. elong., Teucr. Scorod.
2641. Erebia aethiops *Esp.*, 9–11 mm. (cf. No. 2643).—Knaut. arv.
2642. E. ligea *L.*, 9 mm.—Rubus frutic., Senec. nemor., Cirs. pal., Hierac. vulg., Thym. Serp.
2643. *E. Medea S.V.* (=E. aethiops *Esp.*, cf. No. 2641).—Leont. hast.
2644. E. medusa *S.V.*, 8–9 mm.—Eupator. cannabin.
2645. Hesperia actaeon *Rott.*—Ononis spin. F±I±.
2646. H. comma *L.*, 15–16 mm.—Coron. var. F±I±, Rubus frutic., Knaut. arv., Cirs. arv., C. spinosiss., Carduus crisp., Echium vulg., Stachys Beton. F±I+, Colchic. aut.
2647. H. lineola *O.*—Ranunc. Ling., Dianth. delt., D. Carthus., Agrost. Gith., Medic. sat. F+I+, Trif. med., T. agrar. F+I+, Vicia Cracca F±I+, Knaut. arv., Daucus Car., Eupat. cannab., Cirs. arv., Carduus nut., Leont. aut., Achill. Millef., A. Ptarm., Erythr. Cent.
2648. H. sylvanus *Esp.*, 16 mm.—Dianth. Carthus., Agrost. Gith., Malva mosch., Hyperic. perfor., Medic. falc., Trif. mont. F+I+, T. prat. F+I+, T. rub., Lathyr. heterophyll. ? F+I+, L. pal. ? F+I+, Cirs. arv., C. pal., Onopord. Acanth., Leont. hast., Achill. Millef., A. Ptarm., Echium vulg., Prun. vulg., Euphorb. Cypariss.
2649. H. Thaumas *Hufn.* (=*H. linea S.V.*), 14–15 mm.—Dianth. delt., Agrost. Gith., Medic. sat. F+I+, Trif. prat., T. alp. F+I+, T. arv., Pulicar. dysent., Chrysanth. Leucanth., Centaur. Jacea, Jas. mont., Call. vulg., Lycops. arv.
2650. H. sp.—Delphin. Cons. F±I+, Trif. rep. (F+I+), Lathyr. tuber. F±I+, Cirs. lanceol., Sonchus arv., Hierac. umbell.

2651. *Hipparchia hyperanthus L.* (=Epinephele hyperanthus *L.*, cf. Nos. 2638 and 2703).—Cak. marit.
2652. *H. janira L.* (=Epinephele janira *L.*, cf. No. 2640).—Viola corn.
2653. *H. semele L.* (=Satyrus semele *L.*, cf. No. 2704).—Cak. marit., Senec. Jacob., Parn. pal., Jas. mont.
2654. Leucophasia sinapis *L.*, 10 mm.—Ranunc. acris, R. rep., R. bulb., Melamp. nemor.
2655. Limenitis camilla *S.V.*—Ligust. vulg., Valer. offic.
2656. L. sibylla *L.*—Rubus frutic., Libanot. mont.
2657. *Lycaena adonis S.V.* (=L. bellargus *Rott.*, cf. No. 2666).—Origan. vulg.
2658. *L. aegon S.V.* (=L. argyrotoxus *Bgstr.*), 7–9 mm.—Trif. mont., F+I+, T. arv. F+I+, T. agrar. ♂ F+I+, Lotus corn. F±I+, Onobr. viciif., Vicia angustif. F±I+, V. hirs. F±I+, Achill. Millef., A. Ptarm., Centaur. Cyan., Jas. mont., Cynogloss. off., Mentha sylv., Thym. Serp.
2659. *L. alexis S.V.* (=L. icarus *Rott.*, cf. No. 2671).—Origan. vulg.
2660. *L. alsus S.V.* (=L. minima *Fuessl.*, cf. No. 2672), 5–5½ mm.—Chrysocoma Linosyr.
2661. L. arcas *Rott.*—Sanguis. offic.
2662. L. argiolus *L.*—Medic. sat. F+I+, Rubus frutic., Hierac. Pilos., Vacc. ulig., Salix cin., S. Capr., S. aurit.
2663. L. argus *L.*, 8 mm.—Ononis spin. F±I±, Coron. arv.
2664. L. arion *L.*, 8 mm.—Vicia Cracca F±I+.
2665. L. baetica *L.*—Colutea arbor.
2666. L. bellargus *Rott.* (cf. No. 2657).—Lathyr. latif., Bupleur. rotundif.
2667. L. corydon *Poda*, 9–11 mm.—Medic. falc., Trif. mont F+I+, T. rub., Onobr. viciif., Anthem. tinct., Centaur. Jac., C. Scab., Thym. Serp.
2668. L. damon *S.V.*, 8 mm.—Genista tinct. F±I±, Lotus corn. F±I±, Lathyr. tuber. F±I±, Centaur. Cyan., Erythr. Cent., Allium rot.
2669. L. euphemus *Hb.*—Sanguis. off., Echium vulg.
2670. L. hylas *Esp.*—Anthyll. Vuln.
2671. L. icarus *Rott.* (cf. No. 2659), ♂ 7–8 mm., ♀ 8–10 mm.—Ranunc. acris, R. rep., R. bulb., Dianth. delt., Coron. Fl.-cuc., Medic. sat. F+I+, Trif. procumb. F+I+, Lotus corn. F±I+, Onobr. viciif., Lythr. Sal. F+I+, Succisa prat., Cirs. arv., Leont. aut., Hierac. vulg., H. umbell., Achill. Millef., A. Ptarm., Call. vulg., Myosot. pal., Thym. Serp., Prun. vulg., Verben. off.
2672. L. minima *Fuessl.* (cf. No. 2660).—Anthyll. Vuln. F+I+.
2673. L. orion *Pall.*—Sedum acre.
2674. L. semiargus *Rott.*, 7–8 mm.—Ranunc. acris, R. rep., R. bulb., Trif. rep. (F+I+), T. alp. F±I±, T. med., Anthyll. Vuln., Lotus corn. F±I+, Rubus caes., Eryng. marit., Knaut. arv., Jas. mont., Armer. elong.
2675. L. sp.—Acon. Nap. F±I+, Raphan. Raph., Polyg. com., Trif. alpin., Lotus corn. F±I+, Eupator. cannabin., Aster alp., Pulicar. dysent., Centaur. Scab., C. Jac., Crep. bien., Echium vulg., Origan. vulg.
2676. Melanargia galatea *L.*, 11–13 mm.—Dianth. Carthus, Trif. prat. F+I+, T. alp. F+I+, F±I±, T. med., T. rub., Astrag. glycyph. F±I+, Vicia Cracca F±I+, Eupator. cannabin., Anthem. tinct., Chrys. Leuc., Cirs. arv., Card. crisp., C. glaucus, Onopord. Acanth., Centaur. Jac., C. Scab., C. rhen., Achill. Millef., A. Ptarm., Thym. Serp.
2677. Melitaea athalia *Rott.*, 8½–10 mm.—Helianth. vulg., Hyper. perfor., Genista tinct. F±I±, Medic. falc., Trif. rep. (F+I+), T. mont. F+I+, T. alp. F±I±, Rubus frutic., Inula hirta, Tanacet. Corymb., Chrys. Leuc., Senec. Jacob., Centaur. Scab., Crep. bien. Hierac. vulg., Ligustr. vulg., Erythr. Cent., Melamp. arv., M. nemor., M. cristat., Thym. Serp., Prun. vulg., Antheric. ramos.
2678. M. cinxia *L.*—Echium vulg.
2679. M. parthenie *Bkh.*—Rubus frutic., Leont. hastil., Thym. Serp., Nigrit. angustif.
2680. Nemeobius lucina *L.*—Arab. aren.
2681. Nisoniades tages *L.*—Lotus corn. F±I+, Ajug. rept. F±I+.
2682. Papilio machaon *L.*, 18–20 mm.—Coron. toment., Lythr. Sal. F+I+, Centranth. rub. F+I+, Knaut. arv., Centaur. rhen., Syring. vulg., Antheric. ramos.
2683. P. podalirius *L.*, 17–19 mm.—Coron. toment., Trif. prat., Centranth. ruber F+I+, Syring. vulg., Ajug. rept. F±I+.

2684. Pararge achine *Scop.*—Ranunc. acris, R. rep., R. bulb.
2685. P. egeria *L.*—Eupator. cannabin.
2686. P. maera *L.*—Jas. mont., Thym. Serp.
2687. P. megaera *L.*, 13–14 mm.—Genista tinct. F±I±, Trif. prat. F+I+, Centaur. Jac., S. salicifol., Tarax. off., Hierac. umbell., Jas. mont., Lycops. arv.
2688. Parnassius apollo *L.*, 12–13 mm.—Centranth. ruber F+I+.
2689. P. delius *Esp.*, 10–16 mm.—Carduus deflorat.
2690. Pieris brassicae *L.*, 16 mm.—Anem. japon., Ranunc. rep., Cardam. prat., Hesper. matron., Sisymbr. off., Brass. nig., Sinap. arv., Lunar. ann. F+I+, Cak. marit., Viola sylv., V. can. F+I+, V. tric. vulg. ♀ and ♂ F+I+, V. tric. arv. F+I+, Dianth. delt., D. barb., Vaccar. parvifl., Viscar. vulg., Coron. Fl.-cuc., Agrost. Gith., Malva sylv., M. alc., Medic. sat. F+I+, Trif. rep. (F+I+), T. prat. F±I+, Lotus corn. F±I+, Desmod. canad., Lathyr. latif. var. ensif., L. latif. var. intermed., Prunus dom., P. avium, P. Cer., Rubus frutic., Lythr. Sal., Philad. coron., Tellima grandifl., Centranth. ruber F+I+, C. angustifol., Knaut. arv., Succ. prat., Scab. Columb., S. daucoid., S. Hladnik., S. atropurp., Eupator. purpur., Vernonia fascicul., V. praealta, Aster Amellus, A. floribund., A. Lindleyan., Biotia Schreberi, Galatella punct., Bellis per., Silv. Asterisc., S. connat., S. perfoliat., Helen. autumn., Helianth. divaricat., Chrysostemma tripteris. Coreopsis lanceol., Rudbeckia speciosa, Achill. grandifol., Anthem. tinctor., Doronic. austriac., Senec. nemor., Cirs. arv., C. lanceolat., C. pal., C. olerac. × C. acaule, C. monspessulan., C. serrulat., Carduus acanthoid., Centaur. Jac., C. nigra, C. Scab., C. rhen., C. Astrach., C. Salonit., Leont. hastil., Picr. hieracioid., Scorzon. hum., Tarax. off., Sonchus olerac., S. arv., Hierac. Pilos., H. umbellat., Syring. vulg., Asclep. tenuif., Conv. arv., Lycops. arv., Echium vulg., Caryolopha sempervir., Lithosperm. arv., Salv. Verben., S. sclareoid., Monarda fistul., M. fistul. var. mollis, Origan. vulg., Thym. Serp., T. vulg., Satureia hort., Calamintha alp., Clinopod. vulg., Nepeta Mussini F+I+, N. macrantha F+I+, N. lophantha, N. Glech. (F+I+), Galeops. Ladan. F±I+, Stach. pal., S. grandifl., Physostegia virgin., Ball. nigra F+I+, Ajug. rept. F±I+, Teucr. Cham., T. canum, Blephilia hirs., Polygon. Fagop., P. Bist., P. Pers., Scilla sibir.
2691. *P. crataegi L.* (=Aporia crataegi *L.*, cf. No. 2615).—Rubus frutic.
2692. P. daplidice *L.*—Centaur. rhen., Anchusa off.
2693. P. napi *L.*, 10–12 mm.—Arab. aren., Cardam. prat., Hesper. matron., Sisymbr. off., Sinap. arv., Cak. marit., Raphan. Raph., Viola sylv., V. can. F+I+, V. tric. arv. F+I+, Dianth. delt., Stell. Holost., Cerast. arv., Geran. prat., G. Robert., Erod. cicut., Medic. sat. F+I+, Trif. rep. (F+I+), T. rub., Phaca alp., Onobr. viciif., Prunus dom., P. avium, P. cer., Rubus frutic., Epil. mont., E. roseum, Lythr. Sal. F+I+, Philad. coron., Aegopod. Podagr., Pimpin. Saxifr., Gal. Mollugo, Valer. dioica, Knaut. arv., Succ. prat., Scab. atropurp., Eupator. cannabin., Achill. Millef., A. Ptarm., Chrys. Leuc., Cirs. arv., C. lanceolat., Card. crisp., Onopord. Acanth., Centaur. Jac., C. nigra, Thrinc. hirta, Tarax. off., Sonchus arv., Hierac. muror., H. umbellat., Jas. mont., Syring. vulg., Conv. arv., Echium vulg., Lithosperm. arv., Myosot. sylv., M. interm., Mentha aquat., M. sylv., Salv. sylv. F±I±, S. off. F±I+, Origan. vulg., Thym. Serp., Prun. vulg. F+I+, Ajug. rept. F±I+, Teucr. Scorod., Polygon. Fagop., Commelina tuber.
2694. P. rapae *L.*, 13–18 mm.—Hesper. matron., Sisymbr. off., Sinap. arv., Cak. marit., Raphan. Raph., Viola sylv., V. can. F+I+, V. tric. arv. F+I+, Dianth. delt., Coron. Fl.-cuc., Stell. Holost., Malva sylv., Hyper. perfor., Linum usitat., Geran. pal., Erod. cicut., Medic. sat. F+I+, M. falc., Trif. alp. F+I+, Oxytropis pil., Vicia Cracca F±I+, Lathyr. sylvest. F±I+, L. tuber. F±I+, Prunus dom., P. avium, P. Cer., Potent. sylv., Epil. parvifl., Lythr. Sal. F+I+, L. hyssopif., Philad. coron., Eryng. Camp., Toril. Anthr., Centranth. ruber F+I+, Dipsacus sylv., Succ. prat., Scab. Columb., Eupator. cannabin., Bell. per., Helen. autumn., Achill. Millef., A. Ptarm., Senec. Jacob., Cirs. arv., C. pal., Card. crisp., Centaur. nigra, Picris hieracioid., Tragopog. prat., Scorzon. hum., Tarax. off., Sonchus arv., Crep. vir., Hierac. umbellat., Jas. mont., Syring. vulg., Menyanth. trif., Erythr. Cent., Conv. arv., Lycops. arv., Echium vulg., Lithosperm. arv., Myosot. interm., Linar. Cymb., Salv. sylv. F±I±, Origan. vulg., Satureia

hort., Nepeta Glech. (F+I+), Galeops. Tetr. F±I+, Stach. pal., Ball. nigra F+I+, Ajug. rept. F±I+, Polygon. Pers., Antheric. ramos.

2695. Pieris sp.—Delphin. Cons. F±I+, Matth. incana, M. annua, Sinap. arv., Thalaspi rotundifol., Res. odor., Prunus dom., Rubus frutic., R. Id., Epil. hirs., E. parvifl., Astrant. maj., Knaut. arv., Inula viscosa, Achill. Millef., Echinops sphaeroceph., Cirs. arv., C. olerac., Lappa minor., Serratula tinctor., Centaur. Jac., Leont. aut., Hierac. Pilos., Camp. pat., Trachel. coerul., Anchusa sempervir., Myosot. sylv., Lycium vulg., Digital. purp., Salv. prat. F±I±, Lavand. vera, Mentha piper., Thym. Serp., Stachys Beton. F±I+, Ball. nigra F+I+, Hotton. pal., Armer. elong., Colchic. aut.

2696. Polyommatus alciphron *Rott.*—Rubus frutic., Prun. vulg.

2697. P. dorilis *Hufn.*, 8 mm.—Ranunc. acris, R. rep., R. bulb., Viola tric. arv. F+I+, Cerast. arv., Lythr. Sal. F+I+, Valerian. olitor., Succ. prat., Chrysoc. Linosyr., Bellis per., Pulicar. dysent., Tanacet. vulg., Hierac. Pilos., H. umbellat., Jas. mont.

2698. P. hippothoë *L.*—Polygal. vulg., Polygon. Bist.

2699. P. phlaeas *L.*—Ranunc. acris, R. rep., R. bulb., Dianth. delt., D. Carthus., Cerast. arv., Medic. sat. F+I+, Trif. arv. F+I+, Potent. Anser., P. sylv., Eryng. marit., Angel. sylv., Knaut. arv., Succ. prat., Aster Tripol., Biotia macroph., Achill. Millef., A. Ptarm., Matric. inod., Tanacet. vulg., Chrys. Leuc., Senec. Fuchsii, S. Jacob., Cirs. arv., Centaur. Jac., C. nigra, Leont. aut., Hypoch. rad., Hierac. umbellat., Jas. mont., Call. vulg., Erica cin., Myosot. sylv., Mentha aquat., Origan. vulg., Thym. Serp., Polygon. Fagop., Salix rep.

2700. P. virgaureae *L.*, 8–9 mm.—Aneth. grav., Achill. Millef., Crep. tectorum, Phyteuma orbic., Thym. Serp.

2701. P. sp.—Rumex spec., Lil. bulbif.

2702. Rhodocera rhamni *L.*, 16–17 mm. (cf. No. 2637).—Hepat. tril., Glaucium flav., G. cornicul., Cardam. prat., Raphan. Raph., Viola odor. F+I+, V. sylv., V. can. F+I+, Dianth. delt., D. Carthus., Medic. sat. F+I+, Vicia sat. F±I+, Lathyr. sylvest. F±I+, L. latif., Lythr. Sal. F+I+, Dipsac. sylv., Knaut. arv., Scab. Dallaportae, Tussil. Farf., Silph. Asteriscus, Cirs. arv., C. serrulat., Hypoch. rad., Tarax. off., Hierac. Pilos., H. umbell. Pulmon. off., Echium vulg., Salv. sclareoid., Thym. Serp., Lam. purp. F+I+, Scutell. galeric. ? F+I+, Ajuga rept. F±I+, Prim. elat. F+I+, P. veris F+I+, P. vulg. F+I+, P. Auric. F+I+, Daphne Mez., Hyac. orient.

2703. *Satyrus hyperanthus L.* (=Epinephele hyperanthus *L.*, cf. Nos. 2638 and 2651). —Medic. sat. F+I+, Thym. Serp.

2704. S. semele *L.* (cf. No. 2653).—Knaut. arv., Thym. Serp., Armer. elong.

2705. Spilothyrus alceae *Esp.*—Malva Alcea, Dauc. Car.

2706. *Syrichthus alveolus Hub.* (=S. malvae *L.*, cf. No. 2708).—Chrys. Leuc., Tarax. off., Ajug. rept.

2707. S. alveus *Hb.*, 9–13 mm.—Libanot. mont.

2708. S. malvae *L.* (cf. No. 2706).—Dianth. Carthus., Trif. alp. F±I±, Lotus corn. F±I+.

2709. Thecla betulae *L.*—Heracl. Sphond., Anthrisc. sylv.

2710. T. ilicis *Esp.*—Onobr. viciif., Rubus frutic., Solid. Virgaur., Inula hirta, Anthem. tinctor., Thym. Serp.

2711. T. pruni *L.*—Ligustr. vulg.

2712. T. quercus *L.*—Libanot. mont., Eupator. cannabin.

2713. T. rubi *L.*, 8 mm.—Arab. aren., Cardam. prat., Medic. lupul., Sorbus Auc., Cirs. arv., Vacc. ulig., Androm. polif.

2714. T. spini *S.V.*—Lotus corn. F±I+, Tanacet. corymb., Thym. Serp.

2715. T. sp.—Crep. bienn.

2716. Vanessa antiopa *L.*—Tussil. Farf.

2717. V. atalanta *L.*, 13–14 mm.—Sinap. arv., Astrant. maj., Eryng. marit., E. camp., Knaut. arv., Succ. prat., Aster Novae-Angl., Tanacet. vulg., Onopord. Acanth., Stachys grandifl.

2718. V. calbum *L.*—Succ. prat., Eupator. purpur., Oenanth. aquat., Nepeta Mussini F+I+.

2719. V. cardui *L.*, 13–15 mm.—Thlaspi rotundif., Viola odor., Lotus corn. F±I+, Lathyr. latif., Onopord. Acanth., Centaur. rhen., Erica carn., Anchusa off., Ball. nigr. F+I+.

2720. V. io *L.*, 17 mm.—Nigella arv., Delphin. Ajac. F±I+, Glaucium flav., G. cornicul., Berter. incana, Sapon. off., Lathyr. sylv. F±I+, Prunus spin., Libanot. mont., Scab. atropurp., Eupator. cannabin., Tussil. Farf., Aster Novae-Angl., A. salicifol., Chrysanth. seget., Cacalia hast., Senec. sarracen., Echinops sphaeroceph., Cirs. arv., Carduus acanthoid., Onopord. Acanth., Carlina acaulis, Serrat. tinct., Centaur. Jac., S. Scab., Tarax. off., Hierac. hirsut., Ligustr. vulg., Ball. nigra F+I+, Plant. med., Salix rep., Lilium bulbif., Hyac. orient.

2721. V. prorsa *L.*—Rubus frutic.

2722. V. urticae *L.*, 14–15 mm.—Hepat. tril., Ranunc. Fic., Eranth. hiem. F±I±, Matth. incana, Arab. alb., Cardam. prat., Hesper. matron., Erysim. Cheiranthoid., Sinap. arv., Lunar. ann. F+I+, Cak. marit., Viola odor. F+I+, Dianth. Arm., D. barb., Medic. sat. F+I+, M. falc., Trif. prat. F+I+, Lathyr. sylvest. F±I+, Persica vulg., Sedum refl., Astrant. negl., Eryng. marit., Centranth. ruber F+I+, C. angustifol., Knaut. arv., Scab. daucoid., Eupator. cannabin., Tussil. Farf., Aster Amellus var. Bessarab., A. chinens., Biotia Schreberi, Bellis per., Diplopapp. amygd., Bolton. glastifol., Cacal. hast., Cirs. arv., C. lanceolat., C. pal., Onopord. Acanth., Centaur. nigra, C. Scab., C. rhen., C. caloceph., C. oriental., Leont. aut., L. hast., Hypoch. rad., Tarax. off., Hierac. umbell., Lobel. Erin., Campan. rot., Jas. mont., J. perenn., Call. vulg., Erica cin., Syring. vulg., Lycops. arv., Echium vulg., Veron. Tournefortii var. polita, Mentha aquat., Monarda fistul. var. mollis, Origan. vulg., Thym. Serp., Lam. purp. F±I+, Ballota nigra F+I+, Prim. vulg. F+I+, Polygon. Fagop., Daphne Mez., Salix cin., S. Capr., S. aurit., Leucoj. vern., Scilla sibir., Hyac. orient., Muscari racem.

2723. V. sp.—Inula visc., Pulmon. longif.

F. Sphingidae.

2724. Deilephila elpenor *L.*—Lonic. Pericl. F+I+, L. Caprifol. F+I+, Syring. vulg., Melitt. Melissophyll. F+I+.

2725. D. euphorbiae *L.*, 25 mm.—Vicia sat., Melilot. Melissophyll. F+I+, Lilium Martag. (?)

2726. D. galii *Rott.*—Lotus corn. ? F±I+, Phaseol. vulg. ? F±I+, Lonic. Periclym. F+I+.

2727. D. lineata *F.* (=sp. americ. sept.).—Oenoth. missour. F+I+.

2728. D. porcellus *L.*—Melandr. alb., Lotus corn., Lonic. Caprifol. F+I+, Syring. vulg.

2729. D. sp.—Lonic. Caprifol. F+I+.

2730. Ino geryon *Hübn.*—Dianth. Carthus.

2731. I. geryon *Hübn.* var. chrysocephala *Nick.*—Phyteuma orbic.

2732. I. globulariae *Hbn.*—Geran. sanguin., Antheric. ramos.

2733. I. pruni *Schiff.*—Viscar. vulg., Vicia angustif. F±I+.

2734. I. statices *L.*, 9 mm.—Viscar. vulg., Coron. Fl.-cuc., Agrost. Gith., Epil. angust., Knaut. arv., Achill. Millef., Chrys. Leuc., Cirs. arv., Centaur. rhen., Campan. rot., Jas. mont., Nepeta Mussini F+I+, Armer. elong.

2735. Macroglossa bombyliformis *O.*—Salv. prat. F±I+.

2736. M. fuciformis *L.*, 17–20 mm.—Cardam. prat., Coron. Fl.-cuc., Nepeta Glech. (F+I+), Ajug. rept. F±I+.

2737. M. Stellatarum *L.*, 25–28 mm.—Aconit. Nap., Viola calcar. F+I+, Dianth. Carthus., D. barb., Sapon. off., Oenoth. bien. F+I+, Lonic. Periclym. F+I+, Gal. verum, Centranth. ruber, F+I+, Onopord. Acanth., Gent. bavar., G. vern., Erythr. Cent., Phlox panicul., Heliotr. peruv., Echium vulg., Nicot. Tabac. F+I+, Linar. alp., Nepeta Glech. (F+I+), Galeops. versic., Ball. nigra, F+I+, Prim. longifl. F+I+, Lil. Martag.

2738. M. sp.—Lonic. alpigena.

2739. Pterogon proserpina *Pall.*—Sil. nut.

2740. Sesia asiliformis *Rott.*—Medic. falc., Senec. Jacob., Ligustr. vulg.

2741. S. empiformis *Esp.*—Lotus corn. F±I+, Thym. Serp.

2742. S. tipuliformis *Clerck.*—Lepid. sat., Tanacet. Parthen., Thym. Serp., T. vulg.

2743. Smerinthus ocellatus *L.*—Lonic. Pericl. F+I+.

2744. S. tiliae *L.*—Lonic. Caprifol. F±I±.

2745. Sphinx convolvuli *L.*, 65–80 mm.—Sapon. off., Lonic. Periclym. F+I+, L. Caprifol. F+I+, Conv. sep. F+I+, Melitt. Melissophyll. F+I+, Mirabilis Jalappa.

2746. S. ligustri *L.*, 37–42 mm.—Sapon. off., Lonic. Periclym. F+I+, L. Caprifol. F+I+, Syring. vulg.
2747. *S. Nerii L.* (=Deilephila nerii *L.*).—Nerium odor.
2748. S. pinastri *L.*, 28–33 mm.—Lonic. Caprifol., Haben. bif. F+I+.
2749. Zygaena achilleae *Esp.*, 10–11 mm.—Knaut. arv., Anthem. tinct., Cirs. pal., Antheric. ramos., Allium rot.
2750. Z. carniolica *Scop.*—Dianth. Carthus., Medic. Falc., Onobr. viciif., Knaut. arv., Cirs. arv., Carduus crisp., C. acanthoid., Centaur. Jac., C. Scab., Erythr. Cent., Veron. spic.
2751. Z. exulans *Hchw. et Rein.* 10–11 mm.—Potent. aurea, Cirs. spinosiss., Carduus deflorat., Achyroph. unifl., Phyteuma urbic., Pedicul. tuber.
2752. Z. filipendulae *L.*, 11 mm.—Cak. marit., Sil. Otit., Genista angl. F±I±, Trif. prat. F+I+, T. rub., Anthyll. Vuln. F±I+, Lotus corn. F±I+, L. uligin. F±I±, Epil. angust., Knaut. arv., Succ. prat., Achill. Millef., Cirs. arv., Card. crisp., Leont. aut., Campan. rot., Jas. mont., Eric. Tetr., Armer. elong.
2753. Z. lonicerae *Esp.*, 12 mm.—Dianth. Carthus., Trif. rub., Gal. verum, Knaut. arv., Carduus nut., Centaur. Jac., Crep. bienn., Jas. mont., Echium. vulg., Stachys Beton. F±I+, Antheric. ramos, Colchic. aut.
2754. Z. meliloti *Esp.*—Vicia Cracca F±I+, Peuced. Oreosel., Centaur. Jac., Melamp. nemor., Stachys Beton. F±I+, Colchic. aut.
2755. *Z. minos S.V.* (=Z. pilosellae *Esp.*, cf. No. 2757).—Dianth. atrorub., Knaut. arv., Cirs. arv., C. pal., Carduus crisp.
2756. *Z. onobrychis S.V.*—Inula salicina.
2757. Z. pilosellae *Esp.*, 9–10 mm. (cf. No. 2755).—Dianth. Carthus., Ulmar. pentap., Pimpin. Saxifr., Knaut. arv., Echium vulg.
2758. Z. trifolii *Esp.*—Dianth. Carthus., Lotus uligin. F±I±, Knaut. arv., Succ. prat., Chrys. Leuc.
2759. Z. sp.—Trif. prat. (F+I+), Lotus corn. F±I+, Knaut. arv., Tanacet. corymb., Jas. mont., Origan. vulg., Thym. Serp.

G. Tineidae.

2760. Adela croessella *Scop.*—Spir. sorbif., S. salicif., S. ulmif.
2761. A. cuprella *Thnb.*—Alliar. off., Salix cin., S. Capr., S. aurit.
2762. A. fibulella *F.*—Veron. Cham.
2763. A. rufifrontella *Fr.*—Valerian. olit.
2764. A. rufimitrella *Scop.*—Alliar. off.
2765. *A. tombacinella H.-Sch.* (=A. violella *Tr.*, cf. No. 2766).—Achill. Millef.
2766. A. violella *Tr.* (cf. No. 2765).—Caps. Bursa-past., Bellis per.
2767. A. sp.—Arab. sagitt., Carum Car., Knaut. arv., Lycopsis europ., Salix cin., S. Capr., S. aurit.
2768. Asychna modestella *Dup.*—Stell. Holost.
2769. Butalis aeneospersella *Rsslr.*—Lotus corn.
2770. B. laminella *H.-Sch.*—Chrys. Leuc.
2771. Chauliodus iniquellus *Wck.*—Peuced. Oreosel.
2772. Choreutis myllerana *F.*, 3 mm.—Achill. Millef., Matricar. inod., Senec. Jacob.
2773. Coleophora lixella *Zell.*—Thym. Serp.
2774. C. ornatipenella *Hbn.*—Salv. off. F±I±.
2775. Depressaria incarnatella *Zell.*—Cirs. acaule.
2776. Elachista sp.—Asperula odor.
2777. Ergatis heliacella *H.-Sch.*—Dryas octopet.
2778. Gelechia distinctella *Zell.*—Thym. Serp.
2779. G. ericetella *Hbn.*—Call. vulg.
2780. Glyphipteryx equitella *Scop.*—Sedum acre.
2781. Hyponomeuta sp.—Heracl. Sphond.
2782. Lypusa maurella (*S.V.*) *F.*—Pulsat. alp.
2783. Mesophleps silacellus *Hbn.*—Origan. vulg.
2784. Micropteryx calthella *L.*—Ranunc. acris, R. rep., R. bulb., R. auric.
2785. M. spec.—Plant. med.
2786. Mimaeseoptilus pterodactylus *L.*—Mentha aquat.
2787. Nemotois cupriacellus *Hbn.*—Succ. prat.
2788. N. dumeriliellus *Dup.*—Anthem. tinct.
2789. N. minimellus *Zell.*—Succ. prat., Scab. Columb.
2790. *N. scabiosellus Scop.* (=N. metallicus *Poda*).—Knaut. arv., Heracl. Sphond.

2791. N. sp.—Daucus Car.
2792. Pleurota bicostella *Clerck.*—Call. vulg.
2793. P. schlaegeriella *Zell.*—Achill. Millef., A. Ptarm.
2794. Plutella cruciferarum *Zell.*—Senec. Jacob., Mentha aquat.
2795. P. xylostella *L.*—Pulic. dysent.
2796. *Porrectaria sp.*—Medic. lupul. F±I±.
2797. *Simaëthis fabriciana Steph.* (=S. oxyacanthella *L.*, cf. No. 2798).—Toril. Anthrisc., Pulicar. dysent., Achill. Millef., Matric. inod., Senec. Jacob., Leont. aut.
2798. S. oxyacanthella *L.* (cf. No. 2797).—Rubus frutic.
2799. Tinagma dryadis *Stgr.*—Dryas octopet.
2800. Pronuba yaccasella *Riley.*

H. Tortricidae.

2801. Cochylis dipoltella *Hbn.*—Artemis camp.
2802. Dichrorampha plumbagana *Tr.*—Spir. sorbif., S. salicif., S. ulmif.
2803. Doloploca punctulana *S.V.*—Ligustr. vulg.
2804. Grapholitha albersana *Hbn.*—Lonic. Xylost. ? F±I±.
2805. G. asseclana *Hbn.*—Cytis. sagitt.
2806. G. aurana *F.* var. aurantiana *Kollar.*—Heracl. Sphond.
2807. G. caecana *Schläg.*—Onobr. viciif.
2808. G. compositella *F.*—Anthrisc. sylv.
2809. G. fuchsiana *Rsslr.*—Cytis. sagitt.
2810. G. hepaticana *Tr.*—Senec. nemor., S. Jacob.
2811. G. hohenwarthiana *Tr.*—Centaur. Jac.
2812. G. lacteana *Tr.*—Artemis. Camp.
2813. G. mendiculana *Tr.*—Call. vulg.
2814. G. microgammana *Guen.*—Ononis spin. F±I±.
2815. G. pupillana *Clerck.*—Artemis. Absinth.
2816. G. scopariana *H.-Sch.*—Genista tinct. F±I±.
2817. G. succedana *Frröl.*—Cytis. sagitt.
2818. G. trigeminana *Steph.*—Senec. Jacob.
2819. Phoxopteryx myrtillana *Tr.*—Vacc. ulig.
2820. P. unguicella *L.*—Call. vulg.
2821. Teras aspersana *Hbn.*—Call. vulg.
2822. Tortrix inopiana *Haw.*—Eupator. cannabin.
2823. T. sp.—Medic. lupul., Hedera Helix, Leont. aut., Mentha aquat.

VI. HEMIPTERA

1. Heteroptera

2824. Genus et sp. ?—Marrub. vulg. F±I±.
2825. Siphonophora artemisiae *Koch.*—Medic. lupul.

A. Capsidae.

2826. Calocoris bipunctatus *F.* (cf. No. 2829).—Bidens tripart., Helianth. ann., Achill. Millef., Matricar. inod., Senec. Jacob., Centaur. nigra, Leont. aut.
2827. C. chenopodii *Fall.*—Epil. angust., Anthem. tinct.
2828. C. fulvomaculatus *Deg.*—Angel. sylv., Achill. Millef., Matricar. inod., Centaur. nigra, Leont. aut.
2829. *C. norvegicus Gmel.* (=C. bipunctatus *F.*, cf. No. 2826).—Anthrisc. sylv., Tanacet. vulg.
2830. C. roseomaculatus *Deg.*—Knaut. arv., Chrysanth. seget., C. Leucanth.
2831. C. seticornis *F.*—Sherard. arv.
2832. C. sp.—Achill. filipend.
2833. Capsus sp. (cf. No. 2834).—Lythr. Salicar. (F+I+), Carum Car., Tanacet: corymbos., Senec. Jacob., Onopord. Acanth., Centaur. Scab.
2834. *Deraeoceris sp.* (=Calocoris sp., cf. No. 2833).—Caltha pal.
2835. Lygus (Orthops) kalmii *L.*—Astrant. maj.
2836. L. pabulinus *L.*—Helianth. ann., Chrysanth. seget.
2837. L. pratensis *F.*—Chrysanth. seget., Statice Lim.
2838. Miris levigatus *L.*—Leont. aut.
2839. M. sp.—Crithmum marit.

2641. Phymatoma alni L.—Tamarix. sumpfiche.
2651. Tylenchinarma virgultarum L.—Anchusa. sylv.

B. Cimidae.

2642. Acanthosoma sylvarum. L.—Salix rep.
2643. A. sp.—Amen. nemor., Pimpin. Salix., Sium latifol., Angel. sylv., Achill. Millef., herac., Jasion., Carduus acanthoid., Centaur. nigra, Statice pan., Salix am., h. major, h. aurit.
2644. Thrypelepa mutata L.—Salix rep.

C. Coreidae.

2645. Corizus pannonpunctatus Schill.—Achill. filipend.

D. Hydrometridae.

2646. Mesovelia furcata Mulk. et Rey. Carvel.—Trapa natans ? F + I +.

E. Lygaeidae.

2647. Aphanus vulgaris Schill.—Pulicar. vulg., Prunor. Amer.
2648. Lygaeus equestris L.—Adon. vernal. Onopord. Arcanth.
2649. Pyrrhocoris apterus L., 4 pun.—Malva sylv., M. rotundif., Senec. vulg., h. tuberosus, Tarax. off., Lam. purp. P ± I ±.

F. Pentatomidae.

2650. Aelia acuminata L.—Inula thapsoid.
2651. Carpocoris baccarum L.—Hieracia. arv.
2652. C. nigricornis F.—Centaur. aran. Libanot. mont.
2653. Carpocoris viridicollis L.—Salix rep.
2654. Eurydema festivum L.—Libanot. mont.
2655. E. oleraceum L. (cf. No. 2656.)—Arab. aren., Valer. off., Libanot. mont.
2656. E. ornatum L.—Brass. arv.
2657. Eurygaster hottentotta F.-Sch.—Libanot. mont.
2658. E. maura L.—Inula britann.
2659. Graphosoma albomarginatum Goez.—Salix rep.
2660. Graphosoma lineatum L. (cf. No. 2661.)—Centaur. mar., Aegopod. Podagr., Sider. Trilob., Libanot. mont.
2661. G. nigrolineatum F. (=G. lineatum L., cf. No. 2660.)—Daucus Car., Cancalis daucoid.
2662. Peltocoris praenus L.—Libanot. mont.
2663. Peltocoris sp.—Valerian. off.
2664. Strachia oleracea L. (=Eurydema oleraceum L., cf. No. 2655.)—Leont. hast.
2665. Tropicoris rufipes L.—Libanot. mont.

G. Reduviidae.

2666. Nabis sp.—Sider. trilobum.

a. Homoptera.

A. Cercopidae.

2667. Aphrophora sp.—Senec. Jacob., Leont. aut.

B. Aphidae.

2668. Aphis sp.—Medic. lupul.

VII. NEUROPTERA

A. Planipennia.

2669. Chrysopa abbreviata Curt.—Centaur. maculos.
2670. Hemerobius sp.—Anthoxan. sylv., Daucus Car.
2671. Panorpa communis L.—Arum pyth., Spir. serini., S. salicif., S. ulmif., Centaur. maculos., Aegopod. Podagr., Pimpin. Saxifr., Angel. sylv., Heracl. Sphondyl., Anthoxan. sylv., Epipactis cannabina., Solidago saracd., Tamarix. vulg., Asclep. syr., Verbasc. nigr., Mentha aquat.
2672. Sialis lutaria L.—Anthoxan. sylv., Carum Carvi.

B. Trichoptera.

2673. Phryganea sp.—Nuph. lut.

VIII. ORTHOPTERA

1. Pseudo-neuroptera

A. Odonata.

2874. Agrion minium *Harr.*—Pyrus Malus, Veron. Cham.
2875. A. sp.—Spir. sorbif., S. salicif., S. ulmif.

B. Perlidae.

2876. Perla sp.—Caltha palustris *L.*

C. Psocidae.

2877. Psocus sp.—Batrachium aquat.

2. Orthoptera genuina

A. Blattidae.

2878. Ectobia lapponica *L.*—Spir. sorbif., S. salicif., S. ulmif.

B. Forficulidae.

2879. Forficula auricularia *N.*—Anem. japon., Actaea Spic., Papaver Rhoeas, Brass. nig., Tropaeol. majus (F+I+), Hedera Helix, Helianth. ann., Achill. Millef., Cirs. lanceolat., Camp. persicif., Conv. sep.
2880. F. decipiens *Géné.*—Arum Arisar.
2881. F. sp.—Helichrys bracteat.

C. Thripidae.

2882. Thrips sp.—Pulsat. vulg., Anem. nemor., Adonis vern., Ranunc. acris, R. rep., R. bulb., R. auric., R. Fic., Glaucium flav., Brass. oler., Caps. Bursa-past., Res. odor., Sil. acaul., Stell. Holost., S. med., Malach. aquat., Cerast. arv., C. triv., Oxal. Acetos., Ulex europ., Medic. lupul., Lathyr. tuber. F±I±, Fragar. vesca, Pyrus comm., Cotyledon Umbilicus, Lythr. Salicar. (F+I+). Chrysosplen. oppositif., Adox. mosch., Succ. prat., Tussil. Farf., Pulicar. dysent., Antenn. margarit., Tarax. off., Campan. rot., C. persicif., Wahlenbergia hed., Arctostaph. Uva ursi, Call. vulg., Erica Tetr., Vinca min., Conv. arv., C. sep., Cynogloss. off., Atropa Bell., Verbasc. nigr., Digit. purp., Veron. hederif., Melamp. nemor., Lavand. vera, Mentha aquat., Lycop. europ., Melissa off. (F+I+), Prim. vulg., Narc. Pseudo-Narc. F±I±, Brodiaea ixioid.

D. Thysanura.

2883. Lepidocyrtus sp.—Chrysosplen. oppositifol.

IX. GASTROPODA

(G=Gastropod)

A. Helicidae.

2884. Helix aspersa *Müll.*—Rhodea jap. F+G+.
2885. H. hortensis (*L.*) *Müll.*—Calla pal. ? F+G+.
2886. H. vermiculata *Müll.*—Rhodea jap. F+G+.

B. Limacidae.

2887. Limax levis *Müll.* (=*L. brunneus Drap.*).—Chrysanthem. Leucanth.

C. Succinidae.

2888. Succinea spec.—Chrysosplen. alternif. F+G+.

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